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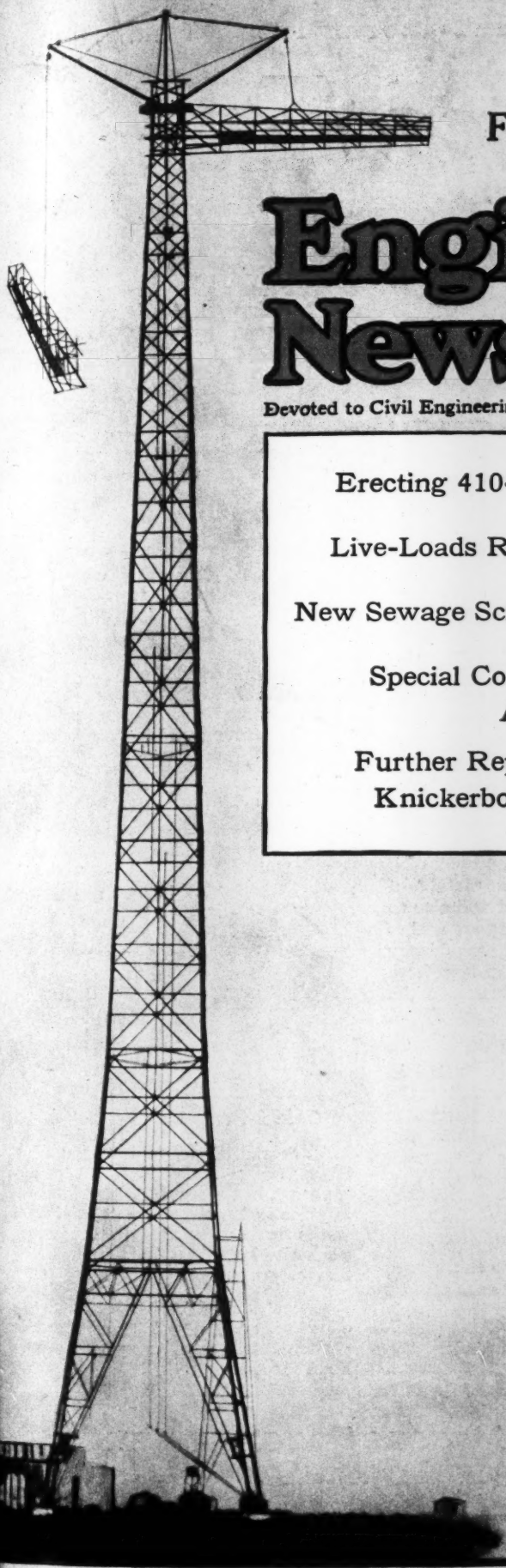


February 9, 1922

Engineering News-Record

Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

Erecting 410-foot Towers for a Radio Central
By David S. Fine

Live-Loads Required for Motor Truck Storage
By E. L. Verveer

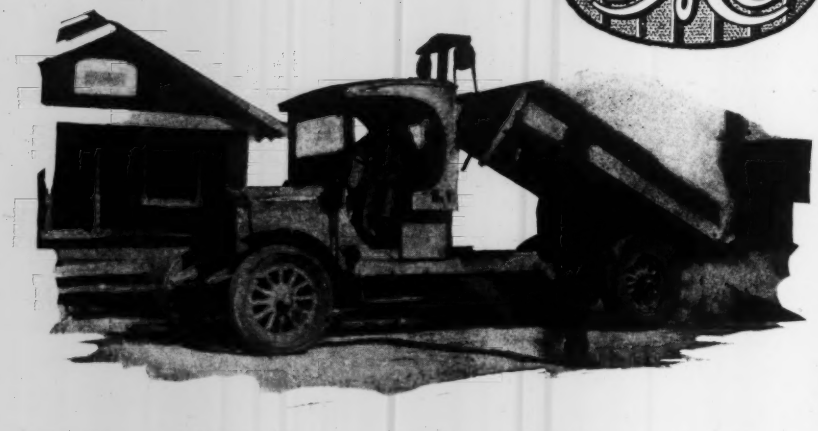
New Sewage Screening Plant at Pleasantville, N. J.
By W. De W. Vosbury

Special Concrete Specified for a Viaduct Across Jamaica Bay

Further Report on the Roof Failure in the Knickerbocker Theater at Washington

Lifting the 8-ton Cross-Arm of a Radio Tower 400 ft. With Derrick Tied Back to Opposite Arm Already Placed.

General Motors Trucks



Deliver 100 Tons of Road Materials Daily

When horses were the motive power for hauling sand, gravel and crushed stone on road building jobs, five teams would have been needed to handle 100 tons of material in a day.

And it goes without saying that even five teams would have had few moments for loafing when doing this granting that even the distance that the loads were carried was short. Yet we can see it done now by a single unit.

Now Done With Truck

At least such is the testimony of the L. L. Beye Construction Company of Eldorado, Kansas, concerning the two-ton GMC truck which was purchased in 1919 for this work. The L. L. Beye Construction Company is a road making outfit and its truck is used exclusively for getting materials onto the road and street jobs in Eldorado.

Not only is this severe work, because of the heavy loads and the constant day upon day usage of the truck, but it also calls for maximum pulling power. Traversing the rutted, torn-up roadway to the construction work; pulling through mud and out of gravel and sand pits; all this you will agree, tests the stamina of any motor truck more in a week than ordinary hauling on smooth roads would in a month. The GMC has done this job faithfully.

It is fitted with pneumatic tires to aid in getting traction on this rough going and carries a hydraulic dump body to facilitate unloading at the job. It is a matter of seconds only to unload and also to load for the Beye Company makes use of the most modern machinery in transferring its materials from cars to chutes and thence to the truck.

100 Tons Daily

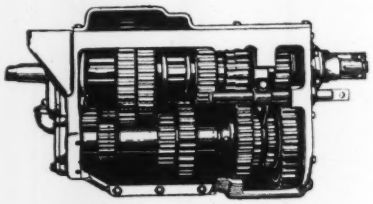
With the work concentrated in Eldorado, as was the case when the performance of this particular GMC truck was checked, the hauls are reasonably short and have made possible the truck taking 100 tons a day. On country work with longer hauls, this tonnage would, of course, be curtailed. But whether a long or a short haul, the GMC would carry each trip its maximum load and do it easily.

GMC trucks are designed and built to meet hauling problems. Not only are they trucks of established and proved ability but they are far in advance of the general trend of motor truck design in their features of construction, which makes for more economical operating costs and rapid and inexpensive replacements.

Many Improvements

Motor truck users everywhere hail the GMC Two-Range Transmission as a most important step forward in motor truck development, because its power range makes it possible to now have both speed and pulling power in the same chassis. By giving two-gear reductions to the counter shaft, the transmission has two distinct ranges, one for ordinary driving conditions and the other, the lower one which produces 30 per cent more power for the heavy going on bad roads. All this, with only five additional major parts to those of the regular four-speed transmission.

In such other improvements as removable cylinder walls, pressure lubrication, removable valve lifter assemblies, instantaneous centrifugal governor and dual cooling system, GMC trucks offer the motor truck user every possible advantage



GMC 2-Range Transmission

Moreover, the complete line of GMC trucks from one to five tons capacity, has recently been reduced in price in keeping with the spirit of the times and substantial reductions also have been made upon all service parts.

A postal card will bring you a copy of our special truck book without obligation on your part. Send for a copy today.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN *Editor*

Volume 88 — NEW YORK, FEBRUARY 9, 1922 — Number 6

Conflicting Society Dates

MUCH criticism was heard at the annual meetings of the American Society of Civil Engineers, the Associated General Contractors, and the American Road Builders' Association, of the fact that these three organizations held their meetings in the same week. It is of no avail, now, to cry over the spilt milk. The important thing is to prevent a repetition in the future. An agency is needed which will record dates of prospective society meetings. We suggest it is an activity for the Federated American Engineering Societies.

Arms Conference Results

IT WILL be recalled that this journal hailed with enthusiasm the calling of the Limitation of Armaments and Far Eastern Conference. The enthusiasm was heightened by the great stroke of Secretary Hughes' opening address. We saw in the conference not merely the obvious and most important possibility, a contribution to peace, but an economic result—in a more confident and less burdened industrial world. We preferred to stress the latter aspect because it is the one allied with that part of our readers' life interests which *Engineering News-Record* is designed to serve.

Now we are at the close of the conference. What are the results? Have the expectations been realized?

For ourselves we answer that the fruits have exceeded the promise. In the arms-limitations, the Pacific and the China treaties we have accomplishments that in peace-making possibilities are epochal. They contrast strongly with previous conferences between nations, when the machinations of statesmen playing with the lives and liberties of millions have resulted in a peace that contained the germs of war and was but the breathing spell in which the combatants prepared for inevitable battle!

The conference has stopped naval rivalry between us and the only nation financially able to give us a naval race. It has, by the same act, rolled back indefinitely danger of war between us and Japan—shall we not also say with Britain, even though there were no clouds or occasions for disagreement visible. It has removed the early likelihood of aggression in China, recognized since the European Armistice as the greatest danger in world politics.

Consequent on these accomplishments has come a spreading of confidence throughout the business world. There is relief from the prospect of a heavy burden for armaments and freedom from the intangible but nevertheless existent fear of war between the United States and Japan. These are economic gains—second, it is true, to the larger benefit of saving of human life—but gains that in the present state of world business will react to the benefit of individuals everywhere.

We are fully aware, of course, that the real justification for our enthusiasm must be looked for ten and twenty years hence. It may be premature. The immediate gain may be followed by a lapse from present high thinking. Nevertheless, the conference has elevated moral leadership to a new plane in international affairs. We shall see whether that appeal goes beyond the statesmen and enlists the sympathy of the common people of every land, so that they may exert themselves and stand fast, as we do in America, against aggression, for peace and for upright dealing between nation and nation.

These results are good as they stand. The immediate effect is excellent. The accomplishments are all that could be expected.

The Knickerbocker Theater Disaster

RELUCTANTLY the mind accepts as real the strange sequence of events revealed in the collapse of the Knickerbocker Theater in Washington. The circumstances of the tragedy are unprecedented in modern building construction, but, though a deep shadow of the unexplained conceals the ultimate moving causes, the course of the final catastrophe is so obvious as to compel belief in spite of its strangeness. Once the facts are accepted they utter certain insistent warnings, which, together with the great toll of death, will make the Knickerbocker Theater long remembered.

From the tangled remains of the structure one may read that the building gradually wedged itself apart during the four years since its erection. It was strong enough to bear its loads, but it was flimsy and lacked bond; under the peculiar conditions of its plan and arrangement this fault led to its destruction. That the final moment when it lost its coherence and fell a wreck-heap came at a time when the theater was occupied seems but the evil play of fate.

So much can be learned from the ruins. More will probably never be determined. Why the roof and walls wedged themselves apart remains an unanswered question, nor is it likely to be answered by anything more positive than inference. The effects of expansion and vibration are not amenable to calculation or test, and it is these effects that must be looked to as the agencies of destruction.

Bolts and anchors to tie together the roof and walls would doubtless have prevented or postponed the collapse. But it will not do to write down this statement as a blanket indictment and record the case as simply one of negligence in planning or building. Bolts and anchors have been omitted in other buildings, and though such practice ever was faulty, and more than elsewhere was faulty in the Knickerbocker structure, yet it has not previously been convicted by disaster. Careful designers have always braced and tied their structures securely, but so far as anchorage is concerned they did this more as a matter of prudence than as one taught by failures.

Buildings, and above all roofs, have been regarded quite universally as dead-load structures in the fullest meaning of the term: as structures devoid of inherent

possibility of shift or displacement. That view is seen to be wrong. In the Knickerbocker at least it was terribly wrong, and potentially it is just as wrong for many another building. *Sound building practice must take full account of the possible cumulative effect of even slight motions or vibrations. It must look upon its structures as live-load structures.* The emphasis placed upon this view is the outstanding gain from the collapse.

No alarm need be felt concerning ordinary buildings because the Knickerbocker Theater collapsed without warning after a period of satisfactory service. The Knickerbocker was not an ordinary building. It involved quite exceptional conditions.

It contained as a main element of its structure a curved wall, a long, thin wall lacking solidity and mass, much broken by doors and windows and devoid of stiffening by piers. Upon this wall the designers supported a truss load of fifty tons. Entering the wall at a sharp angle—another most remarkable condition—the truss nevertheless was placed not upon a square seat but upon one directly in the face of the wall. In this combination even the normal deflection of the truss under the weight of the roof introduced a canting effect and exerted a slight push against the wall.

There was, thus, an initial disturbing force. By reason of the curved wall and the skew truss bearing, expansion and contraction movements of wall or roof took on an abnormal importance. Further, a perceptible tremor was set up by passing street-cars. The building contained an organ, whose notes may have been capable of setting up vibration, and seated in the roof framing it had large motor-driven ventilating fans whose humming noise often was noticed by spectators. It is from these conditions that conclusions as to the genesis of the collapse must be drawn, for no other causative factors have been discovered. And these conditions must be taken into account in judging of the relation of the case to the safety of other buildings.

The precise weight of the several factors, and how far they should have been provided for in the original plan, will doubtless be among the subjects of discussion in the official inquiry. But however exceptional the present case, a simple reference to the inevitableness of vibration and expansion in buildings and to the possibilities of imperfect bearing of heavy members on their supports will suffice to validate the general principle that unless buildings are planned with due regard to their live-load character they will be subject to danger —slight, no doubt, but definitely present.

Two months ago, after the American Theater collapse in Brooklyn, it was urged in these pages that heavy superstructure concentrations should be carried integrally by supporting framework, so that the structural parts of important buildings will form a rigid, self-contained skeleton. From the facts of the Knickerbocker disaster there emerges the clear showing that this principle should have primary and universal application to theaters and other buildings of public assembly, involving a large hazard to human life. *Columns under trusses and girders, securely braced to form a framework capable of resisting all forces acting on the completed building, should be made mandatory in our practices and our regulations governing building.* There is no reason why we should continue to be bound by the traditions of former ages, which made a virtue of utilizing masonry walls for heavy-duty service because better materials of support could not be had.

Building codes are also brought into the focus of attention by the case before us. Regrettable as it may seem, the fact is that the construction of the Knickerbocker Theater was in full accord with the requirements of the Washington building code. Still more regrettable, one of the prime weaknesses of the ill-fated structure was founded on what appears to be error or oversight in that code, namely that no separate provision was made for theater walls, so that the rules set up for ordinary building walls automatically applied also to the walls of a theater. It was under this provision that a hollow-tile wall 18 in. thick was erected to support a 50-ton truss load at a height of nearly 40 ft., and that it was cut into a meshwork of windows and doors to resemble an apartment house—avowedly in order to harmonize with the character of the neighborhood. There will be occasion for revising and improving the Washington code.

What may be accomplished by code improvement is strictly limited, however. Building codes cannot assure safe buildings. They cannot take the place of constructional skill and knowledge. In the Knickerbocker case the code was relied upon as the sheet-anchor of safety. Walls were designed as the code demanded; for that reason they would be safe! Steel roof framing was designed (by the steel contractor), in changing the original design prepared by a consulting engineer, with no other stipulation than that the design must be approved by the city bureau of buildings. Such dependence upon the guardianship of code and routine administrative process, though in good faith, is an easy path to destruction. It is not uncommon among architects, we fear—and no engineer was involved in the Knickerbocker case in authoritative, responsible position. Fostered by excess of detail in code requirements, this dependence upon formal rules needs to be combated by simplification of codes rather than by increase in detail and complexity.

Safety in the last analysis rests upon the personal responsibility of architect and builder.

For a Joint Port of New York

ON ANOTHER page of this issue there is presented in as extended form as space allows the engineering defence of the plan proposed by the city of New York for the development of its port. In next week's issue there will appear the latest analysis by the Port of New York Authority of its solution of the same problem, a solution which has been fully outlined in these pages, but for which up to now there have not been given the cost figures which in the latter report are made public. These two statements, much more fully presented in the original documents of the two bodies, will place before engineers some technical facts which have been lost in the fog of political discussion. In our opinion these facts lead to the conclusion that the Port Authority should be authorized to go ahead with its by no means perfect scheme and that, thereafter, every effort should be made to effect a compromise with the city so that the development of the port can proceed.

Speaking academically, engineering factors should govern in the selection of a proper plan for the port. Practically, however, political influences and legislative procedure seriously affect the solution of the current dilemma. After many years of effort the states of New York and New Jersey are about to pass the final acts

legalizing a joint control of the port, an economic conjunction obviously necessary and one which was practically demanded by the Interstate Commerce Commission decision refusing a freight differential to the New Jersey district. The separate state bills are written so as to compel the Port of New York Authority to proceed along certain very definite lines of physical construction, and no deviation from those lines is permitted except by future legislative enactment. The city, on the other hand, is ordered by a state law to start, within two years, the construction of a tunnel under the Narrows, which must be self-supporting, and this tunnel is not a part of the Port Authority scheme. In order to make this tunnel self-supporting, the city has planned connecting water-front lines in Long Island, a railway and classification yards in Staten Island and a bridge across Arthur Kill to New Jersey and has suggested an outer belt-line in New Jersey which, it thinks, will be so attractive that the trunk line railways will, in their own interests, be required to finance it.

If the port bills go through, and the city continues in its present intention, there will be little if anything done, because no community will allow itself to be saddled with two schemes of such magnitude and cost which contain duplicating features. Some compromise must be reached, and that compromise must be on an engineering basis. In the end, then, engineering considerations must govern.

It may be laid down as a basic engineering principle, not susceptible of contradiction, that the freight traffic in and out of the New York port district must be treated as a whole, regardless of state or city lines. That means that not only should the great ocean traffic of the port be carried through the district at the least expense but that it should discommode as little as possible the internal activities of the district. It means that the various industrial districts, actual and potential, in both states should be encouraged by proper rail connections. It means that the great eastern coast rail traffic should be by-passed around congested areas.

The city's scheme answers these requirements only in part. It does by-pass coast freight, but by a route below the center-of-gravity of trunk line traffic; it relieves congestion in Manhattan and New Jersey, but only insofar as it removes from those districts the freight now going through them, it encourages those industrial areas that lie in the boroughs of Richmond, Brooklyn and Queens and tends to build up the ocean terminals that are or may sometime be in those boroughs. It is, in effect, a New York City scheme, with the biggest part of New York City, that is Manhattan, left out. Furthermore, it depends for its success on the approval of the trunk-line railways, which, according to a letter they have just sent to the city, have decided that they cannot use the Staten Island-Narrows route.

The plan of the Port Authority answers all of the requirements but two; it puts Staten Island (and the city's new $28,000,000 Stapleton piers) on a stub-end and puts a large burden on the congested New Jersey water-front area. Decidedly in its favor is that it is a progressive plan, which can be put into force gradually and which can be revised from time to time, though it would be much better if such revisions did not have to pass the difficult barriers of bi-state legislation.

Staten Island, unquestionably, has great industrial possibilities which would be made actual by a through railroad, though its possibilities as a steamship terminus for east-bound freight can be well cared for for many years to come by lighter service, especially as the Stapleton piers, thanks to the lack of foresight of the city, are not designed for the most effective rail-head service. If Staten Island were connected to the rest of New York by effective rapid-transit passenger service, which the city's scheme does not do, and to the west by a railroad with belt-line connections, its eastward railroad connection could well be left for the future.

As to the contention that added congestion would result from the Port Authority's middle belt, such added congestion will probably not develop until some distant date when the traffic has measurably increased. The first result of this middle belt would be to relieve the immediate pier-head area from its present lighter-bound freight, which is now its greatest burden, and carry it to the joint terminals or the tunnel. When the yards and tracks in this middle belt area cannot longer accommodate the traffic, it will be possible to consider the outer belt with, what will be probably necessary, break-up yards at each railroad intersection. The probable impediment of a low-grade crossing of Newark Bay and Arthur Kill is more serious and will have to be cared for sooner or later by either tunnel or high bridge.

These brief arguments do not consider one of the principal features of the bi-state plan, the automatic electric railway into Manhattan. That is entirely outside the present controversy and something which apparently the Port Authority itself is now ready to put off for some time. There is no great enthusiasm for it outside the bi-state body and most engineers and railway men are still very much in doubt as to its effectiveness or economy. For immediate relief of Manhattan, however, the Port Authority seems willing to put into effect a more systematic control of lighter service and to encourage, if not to direct, store-door delivery and ferry-borne motor truck loads to interior stations. Such plans, not included at all in the city's scheme, are a proper first step toward a solution of Manhattan's freight difficulties.

As to costs, leaving aside the automatic railway, the estimates, each by its own proponent, are, for the city scheme, $110,000,000 (not including the Brooklyn middle belt, estimated by the Port Authority as $40,000,000) and for the bi-state scheme, $128,000,000, including the middle belt but not the Staten Island connection. Each has presented figured savings of great complication, and the railways have prepared others. These seem to indicate that the Port Authority plan would show greater economies, but the basis for all of the figures is on so many unknown and prospective conditions as to make comparison difficult. Certainly the cost prospects are of a most uncertain nature.

The questions of city representation on the Port Authority, the possibility of loss to the city from taxes on property taken over, the probable lack of co-operation of the railways in either scheme—all important features in the situation—are outside the range of this discussion. In our opinion they could well be made a matter of compromise although they are not important enough to kill the Port Authority bills. Under these bills, there is at least a possibility that the great New York port district will be considered as an engineering and economic whole and there seems to be no other way in which it can be so considered. The so-called "comprehensive plan" is not perfect but it is a start toward a solution. If in the future more feasible plans are presented, modification of the present plans can be made.

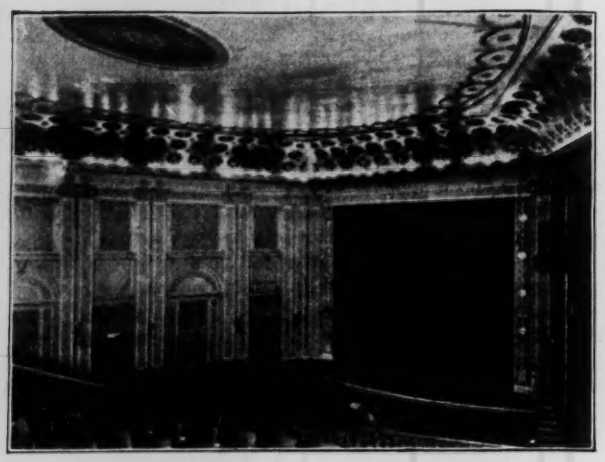


Fig. 1—Interior of Theatre Before Collapse

Fig. 2—Interior of Theatre After Failure

Facts of the Knickerbocker Theater Collapse

No Failure of Roof Steel Preceding Fall Has Been Discovered—Unseating of Main Truss the First Traceable Event—Skew Bearing on Curved Wall—Revision of Steel Design and Field Changes

FULLER examination of the ruins of the Knickerbocker Theater in Washington after the preliminary survey from which our report of last week (p. 207) was prepared confirms that report in its main elements. The steel-frame and concrete-slab roof fell in its entirety, without preliminary fracture of any part of the frame or failure of its supports. It fell within the walls and only one wall is slightly displaced. The bearing points of the steelwork show a sliding-off of the trusses, and all the detail phenomena point to initial unseating of the main truss and the nearby beams resting on the curved north wall. Slowly-acting cumulative causes seem to be responsible. Beyond this point the accident is unexplained; no adequate reason has been found for the unseating. However, the conditions of the truss bearing were abnormal. A review of the chief facts follows.

Drawings of the steel framing and truss diagrams are shown herewith (Figs. 3 and 4), from the design sheets of the fabricator. The detail drawings have only just been found, after being misplaced in a change of ownership of the shop, and were not available for the present report.

History of Work.—When the Knickerbocker Theater was planned six years ago the architect, R. W. Geare, retained M. S. Rich as engineer to design the steel roof framing. Later, the successful bidder for the steelwork stipulated that he be allowed to substitute trusses for the plate-girders and heavy beams to expedite delivery. The architect authorized such change subject to approval of the new plans by the city bureau of buildings, which was duly obtained; he did not check them himself or have them examined by an engineer. The re-design involved extensive change of the arrangement of the framing, so that the resultant design (Fig. 3) is substantially independent of the original design.

Mr. Geare prepared the architectural plans and supervised construction. C. A. Schneider's Sons were the steel contractors, and J. H. Ford of that firm prepared the design. Frank L. Wagner was the general contractor.

Two essential changes were made during the building: (1) As a result of discussion of the stability of the

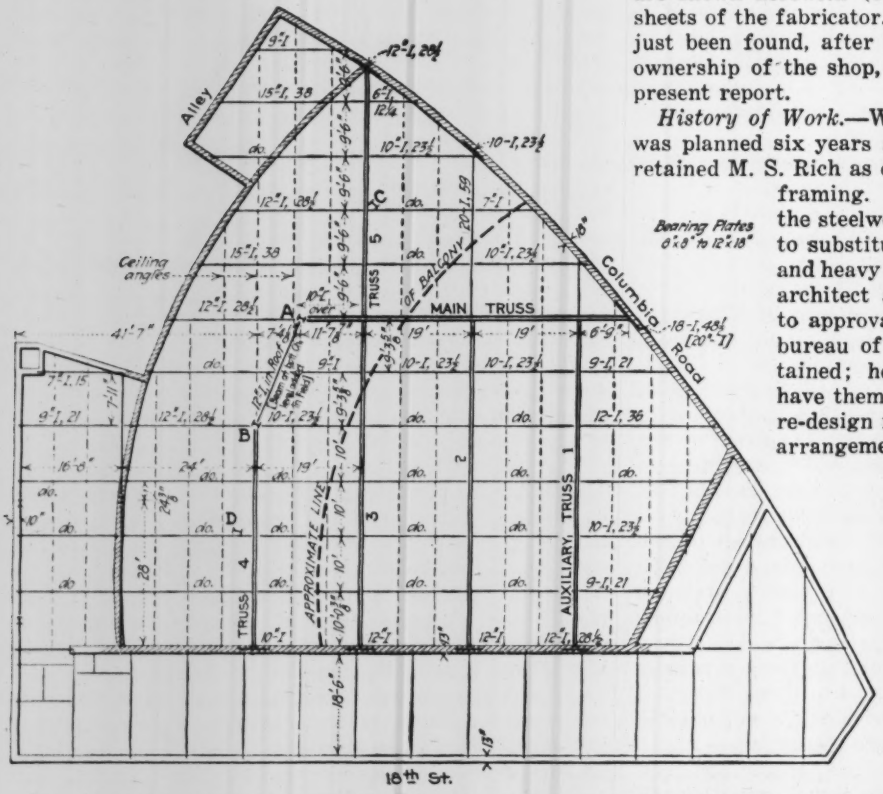


FIG. 3—FABRICATOR'S ROOF FRAMING PLAN OF KNICKERBOCKER THEATER (Eighteenth Street runs about north and south, north being to the right of the plan)

north wall before work started, Mr. Wagner secured the architect's authorization to strengthen this wall by inserting a reinforced-concrete belt course. This course as put in is described as having the full thickness of the wall and a depth of ten or twelve inches. (2) When the steelwork was partly erected, Mr. Geare concluded that the unstayed condition of the top of column *A* was hazardous and ordered a strut put in to connect the two roof columns at bottom-chord level. The strut was put in and is sketched in the perspective detail, Fig. 12.

Except for these changes the work as built was substantially in accordance with the design. The detailing of the steelwork was not first-class in all respects, but no pronounced weakness was developed even in its fall. The field connections were bolted.

Last summer, four years after the completion of the building, the balcony was extended 18 in. at the front to take two additional seat rows, according to Mr. Geare. A cantilever floor was laid on the floor of the bottom platform of the old balcony, consisting of pairs of 4-in. channels laid on the old floor and anchor-bolted into the riser of the first step, and a floor-slab construction supported by these channels. Three rows of seats were set on the extended bottom platform, and the passage-way moved to the first step. The steel supports of the balcony were not strengthened. At this time also the interior of the building was redecorated. No other change was made in the structure and no trouble or need of repairs was reported since the erection of the building, Mr. Geare says.

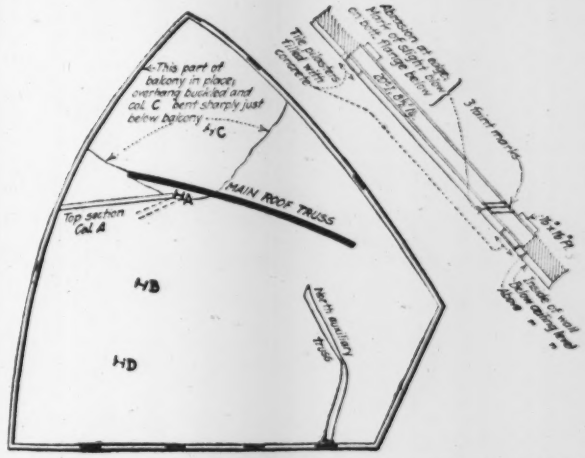


FIG. 5. POSITION OF MAIN PARTS AFTER COLLAPSE
Dotted lines show where upper section of Col. A was moved in clearing.

During the evening performance of Saturday, Jan. 28, at about 9:10 p.m., the roof of the building fell. Of the 400 or 500 people in the theatre at the time nearly 100 were killed—at last reports the fatalities had reached 97. A number of survivors have been able to make eye-witness reports, many of these telling of the fall of plaster or plaster dust near the front of the house, or even directly over the head of the orchestra leader. There has been a report also of a crack being seen to open in the ceiling. But it seems established that all the noticeable happenings at the time of the collapse occurred with such rapidity as to preclude the likelihood of any dependable observation or recollection of events.

Because of the cutting apart and removal of wreckage during the rescue work, knowledge of the position and appearance of the parts of the structure directly after the collapse is fragmentary, and the evidence as to what happened is therefore relatively indirect.

Arrangement of Structure.—Referring to the plan of the steel framing, Fig. 3, it will be seen that two roof columns near the rear of the house carry a truss system centering about a main truss which extends from Column *A* to the curved northwesterly wall. The main truss supports six secondary members (trusses and heavy beams). This column carries a load of about 135,000 lb., maximum roof live-load included. The other column, *B*, carries one end of a secondary truss. The relation of these two columns to the immediately adjacent roof framing is sketched in perspective in Fig. 12, from which it will be seen that Column *A* has a cap at ceiling level on which rests the bottom chord of the main roof truss, while Column *B* has the truss framed into it. In this sketch

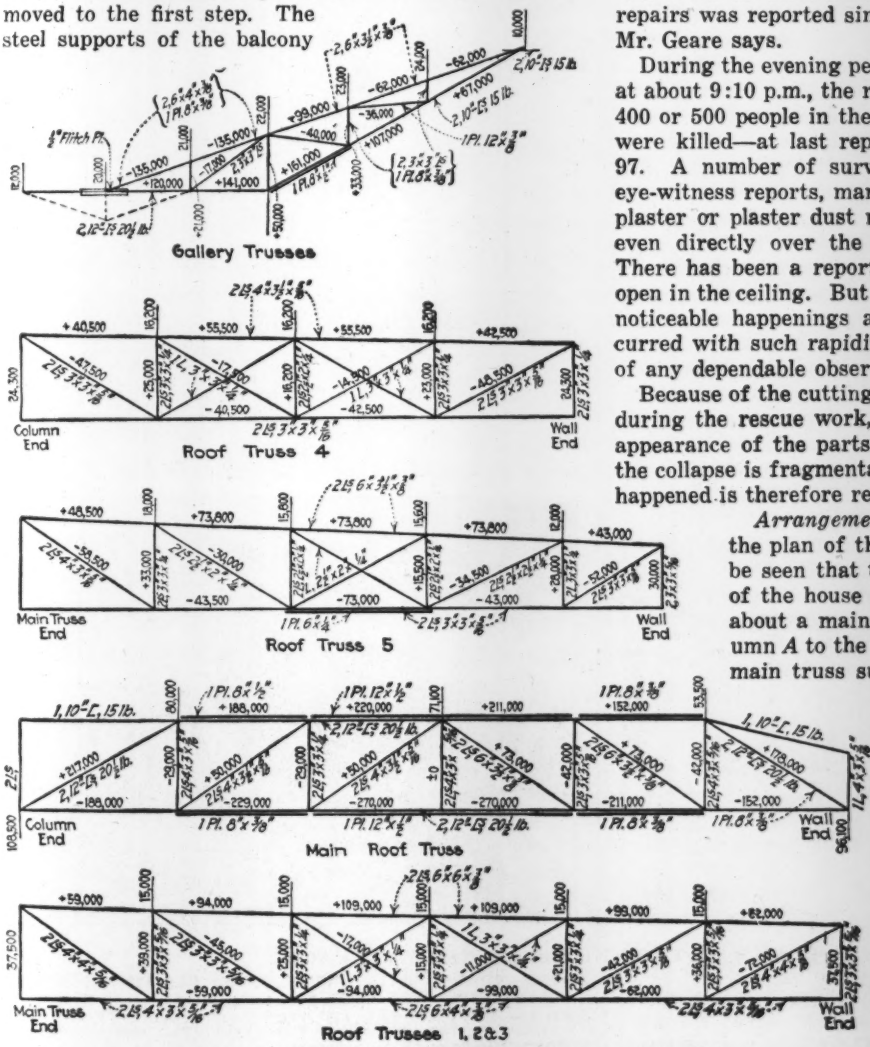
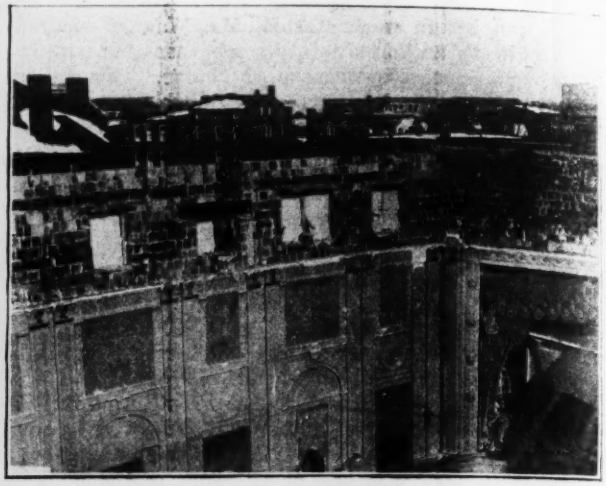
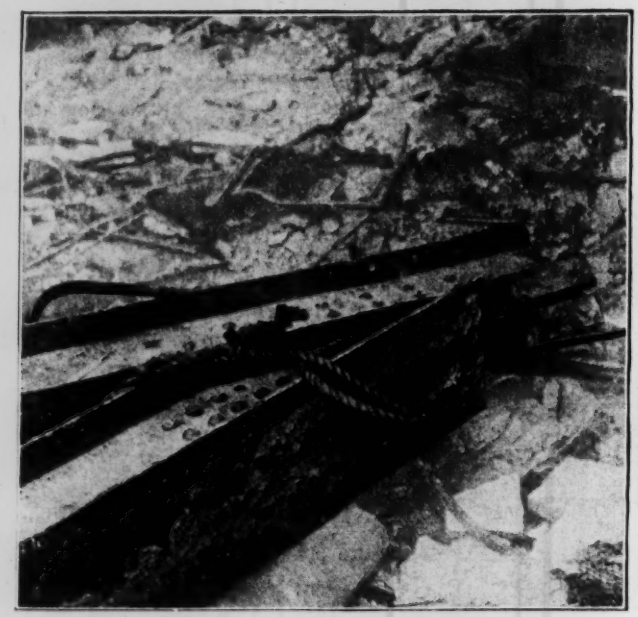


FIG. 4. MAKEUP OF KNICKERBOCKER TRUSSES
From Fabricator's Strers Sheets





SOME DETAILS OF THE KNICKERBOCKER WRECKAGE

FIG. 6—NORTH AUXILIARY TRUSS (TRUSS 1)

FIG. 7—LOOKING WEST TOWARD REMAINING PART OF BALCONY

FIG. 8—SOUTH END OF MAIN TRUSS—Truss was not braced to column; two-angle strut seated on end of top chord and attached by two bolts supported three roof beams

FIG. 9—NORTH WALL, WITH 20-IN. I-BEAM ON WHICH MAIN TRUSS WAS SEATED

FIG. 10—UPPER PART OF THE EAST BALCONY COLUMN (COL. D), REAR FACE UPPERMOST—Column wrenched apart just below balcony truss

FIG. 11—BALCONY REMAINS AND MAIN ROOF COLUMN (COL. 1)—Upper part of column tipped over, top end on floor

appears the 10-in. 23½-lb. I-beam added in the field to brace the structure more completely.

The wall ends of all the trusses were supported by short I-beam distributing girders. The support at the north end of the main truss, for example, was a 20-in. I-beam about 8½ ft. long, supported on 16 x 16-in. steel bearing plates resting on wall piers of the same size. The seat of the truss was 30 in. from the northwest end of this beam. The other trusses were supported on single I-beams of smaller depth. The minor roof beams rested on small steel wall plates bedded in mortar in recesses of the tile wall.

The east and north walls of the auditorium were built throughout of hollow tile, with cells vertical, and were proportioned in thickness according to the requirements of the Washington building code prevailing at that time. The Columbia Road wall (at left in Fig. 1) was detailed in its exterior facade to appear like a three-story building, in order that the structure might harmonize better with the general residential character of the

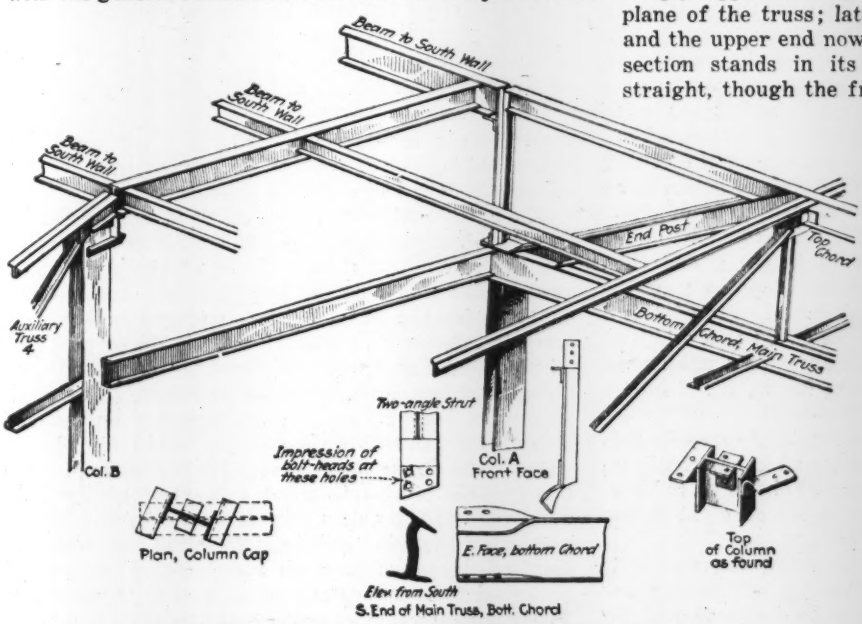


FIG. 12. FRAMING AT TOP OF COLUMNS A AND B
Lower strut between columns added during erection

city. The windows accordingly provided pierced the entire thickness of the wall, but were closed off by cloth screens behind the glass of the sash.

The Collapse.—The entire roof, including steel framing and reinforced-concrete roof slab, fell into the interior, crushing down part of the balcony in its fall. It scratched some of the walls, and left the north or Columbia Road wall leaning out and somewhat cracked. There are several horizontal fissures on the inner face of this wall, at various levels, the lowest not far above ground, the wall is about 5 in. out of plumb (as measured by the city Bureau of Building Inspection), and a wide crack appears at the junction of the proscenium wall. With this exception, the walls are not involved in the accident, and all the seats of trusses and girders are in undisturbed position. Some of them show scratching and bending of the seat face, but none appears to be displaced. One or two beam-seat plates are missing.

Because of lacking knowledge of the position of all the parts of the roof framing, the sketch, Fig. 5, is confined to the parts that were left in the building when the wreckage was cleared out. The north half of the balcony is still in place, though its overhang was crushed down and a short stub column (*C*) supporting the balcony bent over forward to a sharp angle at the bottom of the balcony cantilever. The rest of the balcony was entirely crushed down, and has been removed. The main truss was found hanging across the east corner of the remaining part of the balcony, with its north end lying on the ground some distance east of the original line of the truss; the truss as a whole was 10 or 15 ft. south of its original position in the roof. It was subsequently cut apart with oxygen flame, and the several pieces of the truss now lie on the ground as may be seen in one of the views. Column *A* also went to the south. Its upper section, quite straight and undistorted, was found broken from the lower section at the splice just above balcony floor, but still standing on the lower section and simply tipped over against the south wall, about in the plane of the truss; later it was released from the wall and the upper end now rests on the ground. The lower section stands in its original position, and is quite straight, though the front flange is slightly twisted by lateral bending of the balcony truss overhang. The column is seen clearly in the photograph, Fig. 11. In Fig. 6, the truss leaning against the east wall is the north auxiliary truss (No. 1), fallen a little south of its position in the roof and apparently bent pretty badly in its fall.

No break is found in the main truss, and the truss is nowhere buckled. It exhibits some slight bends at or near the panel points, the first panel point from the south end being bent concave to the west (referred to the original position of the truss) and the other panel points slightly concave to the east. The main column, in spite of a high working stress, also is not buckled. Similarly, all other trusses and main members of the steel framing, as well as the subsidiary beams, show no indications of a primary failure. Numerous cracks, breaks, tears, and distortions are found, but in all cases they are evidently effects of falling or of the wrenching apart of members.

Column Distortions.—Contrasting with the straight and little disturbed condition of the main column, Column *B* is badly distorted in both upper and lower sections. Its several sections were found in the dump heap a mile or more from the building site, and separately sketched give a picture as reproduced in Fig. 13. At bottom-chord level of the truss there is a smooth but short bend in the column, in the plane of the flanges, the rest of the 23-ft. upper section being straight. The lower section is straight from the base plate to the bottom of the balcony truss, but here is folded over forward and to the right very sharply, about 45 deg. beyond a right angle. The bends of lower and upper part are not in the same plane. The destruction of the lower part is doubtless a result of the crushing down of the

balcony, the more so as it is nearly like that seen in Column *C*, where the bending however did not progress so far. The bend of the upper part of Column *B*, free from evidence of great violence, has more static character and may be concluded to have resulted from bending applied by Truss 4, after this had become free of the wall at its east end, and before the crushing of the lower section.

The fourth column of the building, a balcony column (*D*), is broken or torn entirely across just below the level of the balcony framing. This break, to all appearances, is the same as that of columns *B* and *C* at the same level but carried to complete fracture at the fold.

It is evident that none of these column failures was primary, and that all the columns stood up to their work until they were displaced laterally or bent by movement of the roof framing, or were crushed by falling masses from above. Thus, both trusses and columns are free from failure.

Wall Supports.—Examination of the seat of the main truss in the north wall and the seats of the four auxiliary trusses in the east wall discloses the following: The 20-in. I-beam which formed the seat of the main truss, supported on two 16 x 16 steel plates on mortar bedding on the tile wall (which here is carried out 5 in. inside the inner face to form concrete-filled pilasters which are flush with the main body of the wall below the ceiling line), is undisturbed on its bearing plates and shows no evidence of having been jarred or pushed out of place. The top of the beam shows faint scratches having the general direction of the truss, 1½ in. long, and then curving at right angles to the beam, stopping near the edge. The front edge is abraded for a length of 3 or 4 in. near the east edge of the truss chord to a width of perhaps ¼ in. Directly below this abrasion a small mark appears on the edge of the bottom flange, the size of a dime, which may be the effect of a blow; this mark does not go through to the bare metal. As may be seen from one of the photographs, the wall below the beam is practically free from scratches and shows no indentations, although the plaster line is six or eight inches beyond the edge of the I-beam flanges.

In decided contrast, the four auxiliary-truss seats in the east wall all show decided scratching, scoring and abrasions, and in general show a bending down of the inner flange (in the case of the middle two, nearly an inch). Abrasion is most decided in the case of the northerly seat, where at points corresponding to the edges of the truss chord the edge of the beam flange is decidedly cut in. The directions of the scratching and scoring on the top faces of the beams are: Truss 1, nearly at right angles to the wall or inclined a little southwest; Truss 2, about 30 deg. south of west; Truss 3, about 45 deg. south of west; Truss 4, more than 45 deg. Scratches and scorings on the wall below, where the trusses quite evidently struck in their fall, agree with these directions of scoring in indicating a swing or pivoting of the roof steel about points near the south end. The scoring and abrasion of the truss seats indicate that the auxiliary trusses moved on their seats rapidly and under load, while at the seat of the main truss there is no sign of rapid motion.

In the south wall, the beam seat directly in line with the main truss is missing. A plate, presumably this seat, was found in the alley outside the wall, below and three or four feet horizontally distant from the seat location in the wall. There was an appearance of the beam having moved southward (into the wall) 4 in. before pulling out of the wall. The beam seat on either side of this one had a similar appearance.

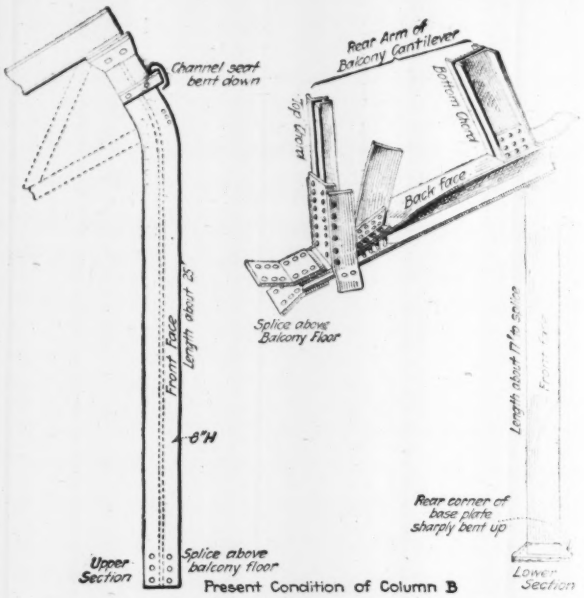


FIG. 13. PRESENT CONDITION OF COLUMN B

The north wall, whose 5-in. outward tipping has been mentioned, shows one or two holes, cut in the wall during the rescue operations. Some of the steelwork lay against the wall near its southwesterly end. Nothing could be learned from officials engaged in the rescue work to indicate that the wall was shaken or pushed out of plumb at this time. Air pressure developed within the auditorium during the fall may have played a part in forcing the wall out. No information on the condition of the wall before the collapse was obtainable.

Probable Cause of Failure.—In the absence of any discoverable steel failure, and in view of the lateral anchorage of the entire roof produced by the interconnection of roof slab and steel framing, only a displacement of the supports of the steelwork on the walls can be looked to as immediate starting-point of the collapse. From the direction of motion of the several parts the fall evidently progressed from the north side or the northeast corner southward.

The appearance of the bearing plates shows that the four auxiliary trusses were pulled off their seats by rapid motion under load, thereby becoming scored and ground. Further, the very great bending downward of two of the seats, which in the case of one of them was even great enough to bend upward the rear flange of the beam, points to the fact that they did not leave their seats until the middle part of the framing was much lower down. On the other hand, the seat of the main truss in the north wall does not show rapid motion under load, and this truss was displaced by a slow movement.

Considering the nature of the framing, it was virtually impossible for a slab failure to bring down the adjacent beams, for a beam failure to destroy the truss carrying it, or for an auxiliary-truss failure to wreck the main truss. Moreover, the appearance of the truss bearings and of the marks showing the direction of the fall make it clear that the auxiliary trusses came down after the main truss. The collapse therefore originated in a fall of the north end of the main truss, which event

would bring about all the effects of the collapse substantially in the way they were observed.

Failure Theories.—Several other critical points which have been under consideration during the examination of the wreckage by Washington engineers and investigating experts should be noted.

The unstable assemblage of parts on the main column, and the bending stress developed in this column by eccentric bearing resulting from truss deflection and from an apparent lack of perfect verticality of the column, has received much study. No buckling or other metal failure of this column occurred, however. Lateral deflection of the top, to east or west, would appear a most obvious danger, but failure in this direction was in a measure forestalled by the brace strut placed between Columns *A* and *B*, and in any event the column did not fail in lateral direction, but moved directly back against the south wall. Primary failure by backward movement of the top of the column could not occur so long as the entire structure was held in place by the roof slab and by the bearing friction of the trusses and beams on their wall bearings. However, such forcing back southward would occur as the first and most necessary result of a fall of the truss at the north wall. Calculations appear to show an uncomfortable overstress in Column *A*. Overstressing of the balcony columns is probable, in view of the widening of the balcony last summer; but only a small part of the full live-load was on the balcony at the ime of the collapse, and the failure of the balcony columns was obviously a result of the roof fall.

Other Observations

Failure of the north auxiliary truss has been discussed, because of a break about mid-length of the top chord, where the north outstanding leg of the top chord shows a rather brittle tension fracture. The truss is bent laterally at this point, and gives every evidence of having been distorted to its present shape by the fall. There is no appearance of buckling.

Reports of persons in the theater that the collapse followed immediately after the fall of some plaster dust or the like on the orchestra leader, who was just giving the signal for the music to begin at the close of the playing of the organ, led to a search for evidence of a beginning of failure in that part of the roof directly in front of the proscenium wall. The plate seats in the wall are in place, and show sliding marks on their top faces. A movement of the entire roof framing away from the north wall (or vice versa) might have carried some of the minor beams off their seats before the main truss was off its seat; but as the dropping of these beams could not have brought down the main truss it would be necessary to conclude that the truss reached the edge of its wall seat only a moment later, and then started the general collapse.

Loads.—As to the load conditions, and especially the heavy snowstorm raging at the time of the collapse, the best estimate of conditions fixes 12 lb. per sq.ft. snow load as maximum allowance. This corresponds to about 2½ in. water, about what was reported by the U. S. Weather Bureau as the precipitation during the storm up to the evening of the collapse. The weight of the motor and fans in the large ventilating hood on the roof, about over the center of the auditorium, does not appear to be a significant item. There was no other extra loading on the structure.

North Wall.—In view of the probability that the main truss was unseated by outward movement of the north wall going on during a long time rather than in one abrupt motion, the construction of this wall is of interest. The wall was in general 18 in. thick in the body, slightly increased in thickness by pilaster formation on the outside; in addition to the 18 in. thickness there was 4 in. of ornamental facing, either brick, stone, or stucco on tile, varying according to location on the wall. The wall was broken by numerous windows and doors, as already mentioned.

Prior to 1913, walls of hollow tile were not admitted as bearing walls in the District of Columbia, but revision of the code in 1913 made such walls permissible on even terms with brick or other walls for buildings up to 40 ft. high. There is no evidence to show that this provision contemplated the construction of walls in open-space buildings such as theaters, but the code appears to have lacked a structural section in its theater portion and therefore made the general structural clauses applicable to theaters as well as to dwellings or stores. Skeleton construction is required for heights above 40 ft. when tile walls are used; the Knickerbocker was about 35 ft. high from curb to bottom chord of roof trusses.

The wall is still in place, and except for an outward tipping and breaking at horizontal joints appears to be unshattered as a whole. No explanation has been found for outward movement of this wall, or in fact for the possibility of such movement without detection. The ornamental ceiling of the auditorium, connecting with the wall plastering by a sweeping cove in which were numerous ornamental ventilation grills, would appear to preclude the possibility that a large outward motion of this wall could have developed in course of time without revealing itself by cracking or tearing apart of the interior finish or the fall of tile fragments as the single-angle roof strut on the end of the bottom chord tore out of the tile in which it was imbedded. Such occurrence would have been brought to the attention of the architect, and Mr. Geare states that nothing of the kind was done.

Summary.—In the face of this absence of advance indications, the physical evidence establishes that the collapse was caused by separation of the main truss and the north wall. It seems probable, but is not clearly proved by the facts available for the present report, that this movement was a slow creep rather than a rapid or violent separation, and in the same degree it seems probable that the wall was a more important factor in the movement than the steel frame.

Motor Fees For Roads Total $108,000,000

Of $108,213,165 collected in registration fees from 9,245,195 passenger cars and commercial vehicles, 28,114 trailers and 177,234 motor cycles as well as chauffeurs' licenses in the 48 states and the District of Columbia, Jan. 1 to July 1, 1921, according to the U. S. Bureau of Public Roads, the sum of $101,793,416 or 94 per cent is available for good roads. The total revenue for the year 1920 in registration fees was $102,546,212.25. The revenue for the first half of this year, therefore, exceeded the entire revenue for 1920 by $5,666,953.08. Of the 9,245,195 registered vehicles, 8,363,427 are passenger cars, 844,110 trucks, and 37,658 are taxis and buses.

Antenna Tower Erection For New York Radio Central

Floating Gin-Pole Erects Body of 410-Foot Tower—Method of Raising the Pole—Cross-Arms 150 Feet Long Weighing 16 Tons Hoisted in Two Counter-balancing Sections—Upper Part of Tower Bolted

By David S. Fine
Assistant Erecting Engineer, American Bridge Co., Philadelphia

IN THE RAPID development of tower-erection methods called forth by the great expansion of radio work during recent years, new requirements are apt to call for improved and modified methods, or ingenious application of existing methods. This was the case with the towers of the New York Radio Central Station at Rocky Point, L. I., where the use of four-legged instead of the usual three-legged construction, and very long, heavy cross-arms led to novel methods of construction. It may be here noted that the 150-ft. cross-arms, weighing 16 tons, were raised in two completely assembled sections to the top of the tower, which furnished a working base only 10 ft. square. Such cross-arms are larger than ever used before but they promise to become a standard feature of radio design.

The station, recently opened by the Radio Corporation of America, occupies a plot of 10 sq.mi. located about

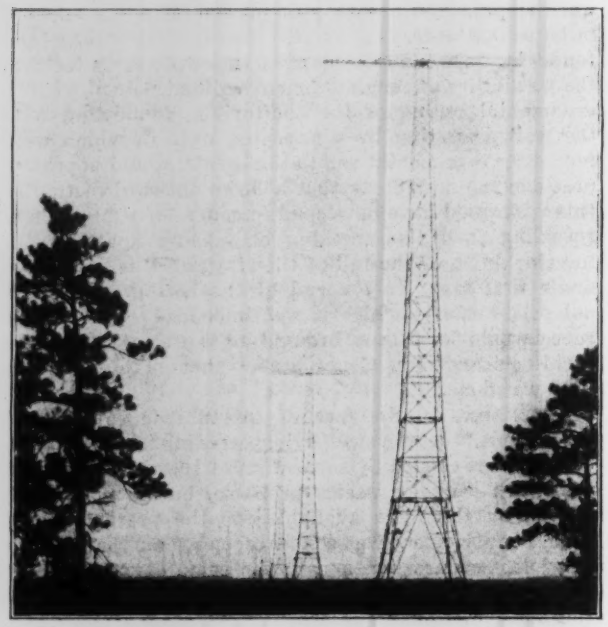


FIG. 1. NEW YORK RADIO CENTRAL; TWELVE 410-FOOT TOWERS

70 miles from New York City. It is planned to have ultimately 72 towers, in twelve radial wings of six towers each, radiating from a central radio power house. When completed it will be the largest and most powerful in existence, and will communicate with all parts of the world.

Twelve towers (Fig. 1), forming two wings of six towers each, were erected. They are spaced about 1,250 ft. apart, making the length of each wing more than a mile. They are 410 ft. high and carry eight antenna wires on either side of the 150-ft. cross-arm. The lower 250-ft. part was riveted and painted, while the remaining 160-ft. height and the cross-arm were bolted, the latter for the reason that this part of the structure is galvanized, to avoid the necessity of closing down a wing for painting near the antenna wires.

The towers are square in plan, and have rolled angle members for diagonal bracing, thereby differing from most of the previously constructed high radio towers, which are three-legged and have adjustable rod bracing. Permanent steel ladders extend from ground to cross-arm, on the outside of the tower. The two end towers of each wing are heavier than the four intermediate towers, though of similar construction, as the antenna

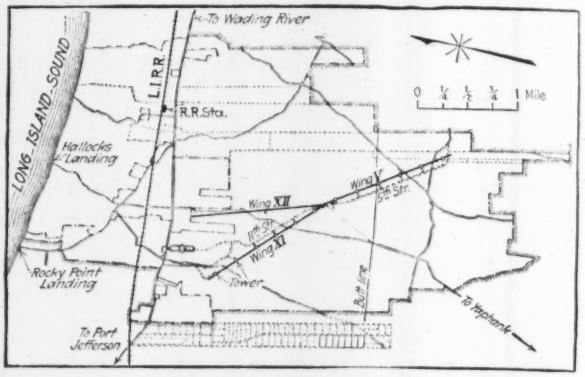


FIG. 2. PLAN OF RADIO CENTRAL AT ROCKY POINT, LONG ISLAND

wires on one side run to the ground instead of the next tower; the weight of an end tower is 142 tons and that of intermediate towers 130½ tons. The total tonnage in all the towers is 1,615 tons.

Material Storage.—The delivering and storage yard was located about 4 mi. from the central power house. Material was handled in the yard by one steel stiff-leg derrick of 12 tons capacity. The steel was not shipped tower by tower, but instead, in the case of the large members the total number of pieces of one kind required for all the towers was shipped together in a car, while in the case of the smaller pieces the total number needed for one tower was wired and shipped together. In the yard the steel was not sorted into twelve towers but all pieces of one kind were kept together.

A road, newly built for the most part, ran from the yard along the tower line, with a short tap road to each tower (see site plan, Fig. 2). The steel was distributed to the tower sites by auto trucks. As shortage of storage space made it necessary to haul the steel as soon as delivered, most of the distribution was done during March and April, when the freezing and thawing of the roads (in sand and clay soil) made hauling difficult.

Erection of Base of Tower.—The base of the tower (Fig. 3) is 60 ft. square and 70 ft. high, a height suitable for erection with a gin-pole. An 80-ft. gin-pole composed of 20-ft. sections of 10-in. gas pipe was raised to vertical position tipping it up with another gin-pole made of a 12 x 12 timbers 30 ft. long; the 80-ft. pole was picked simultaneously at three points.

In erecting the base, as many pieces as practicable

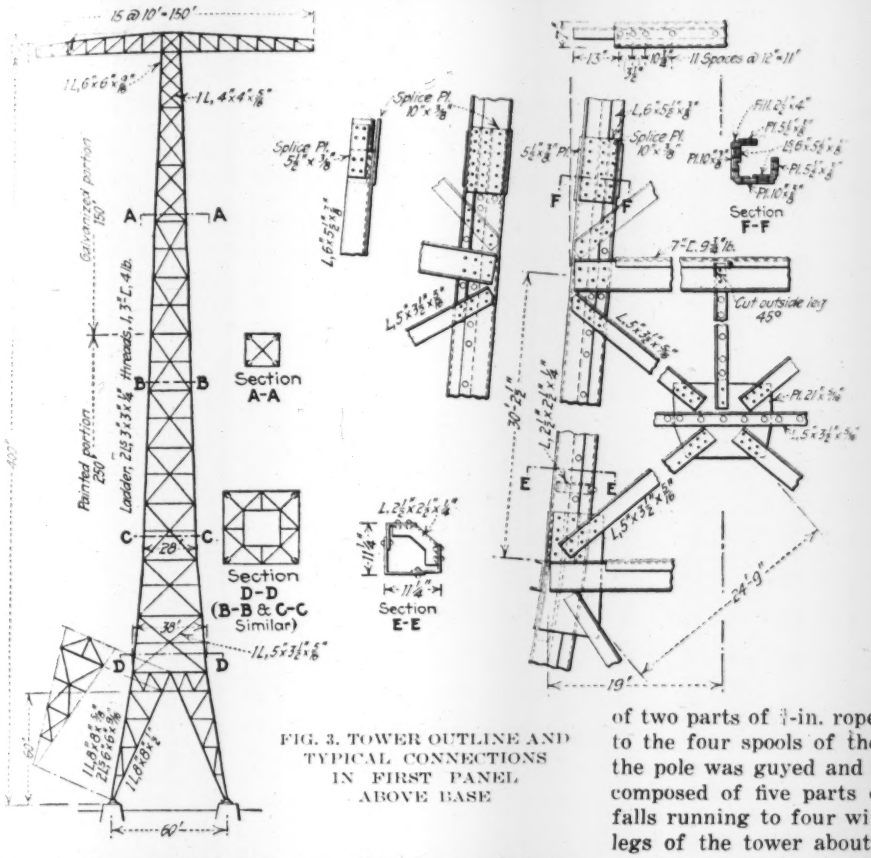


FIG. 3. TOWER OUTLINE AND TYPICAL CONNECTIONS IN FIRST PANEL ABOVE BASE

were bolted together on the ground and erected at one time (see view at left in Fig. 4). The gin-pole, which always worked inside of the tower, could be shifted to any part of the tower and tilted to any angle. The four triangular corner sections of the base were each supported, until connected so as to be self-supporting, by one wire-rope guy running back diagonally. The heaviest piece in the base weighed 3,000 lb., but the heaviest lift was 5,100 lb., this being the base section of leg with two auxiliary legs and bracing.

Erection of Body of Tower.—The body of the tower, composed of 10 panels of 30 ft. and one of 40 ft., is 38 ft. square at the top of the base section and 10 ft. square at the top of the tower. It was erected with a floating gin-pole, which is similar to the ordinary gin-pole except that it is suspended in several sets of falls instead of resting on the ground. The floating pole was the same 80-ft. gas-pipe pole used in erecting the base, with the addition of a steel saucer and fittings at the foot for the attachment of the four suspending falls, and a large special spider at the top. These changes were made while the pole was suspended from a runner line leading from the top of the base.

The floating pole (two views are given in Fig. 4) was rigged entirely with wire rope. It was suspended in four sets of falls composed of two parts of ¾-in. rope, the leads of the falls running to the four spools of the hoisting engine. The top of the pole was guyed and controlled by four sets of falls composed of five parts of ½-in. rope, the leads of the falls running to four winches fastened to the auxiliary legs of the tower about 20 ft. above the ground, one winch at each corner of the tower. The winches had single drums, with handbrakes and pawls, and were supplied as permanent items of the tower equipment, to be placed on the cross-arms for raising the antenna wires. The lower suspending falls were fastened to the tower by means of a wire-rope sling wrapped around the tower leg and over the horizontal strut at a panel point (Fig. 5), while the upper falls were fastened to the tower at the same point in a like manner with another sling wrapped around the tower leg but under the strut. The bottom of the pole was usually about

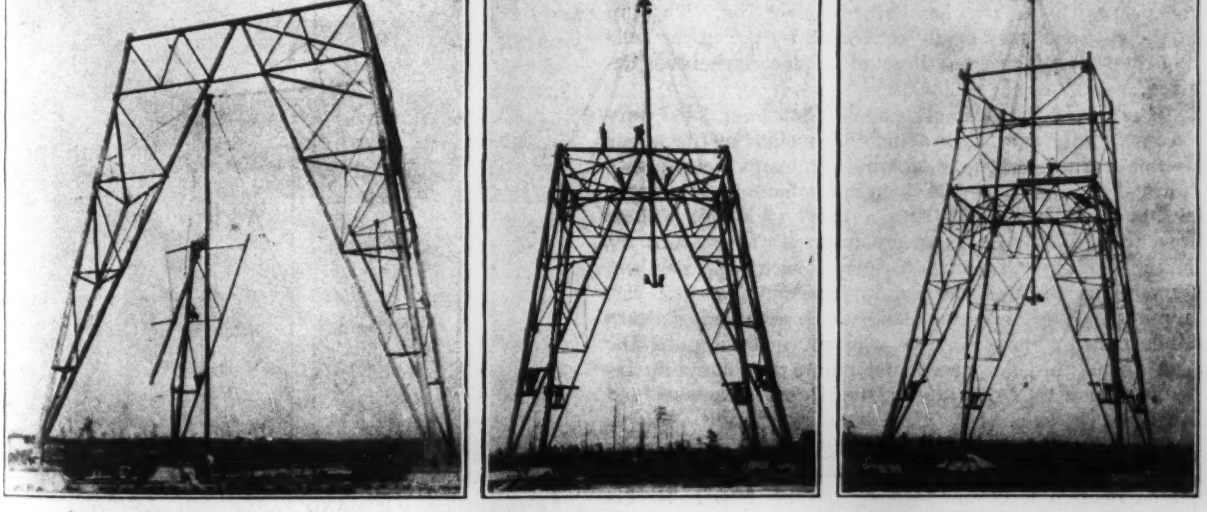


FIG 4. ERECTING BASE AND BODY OF TOWER—FLOATING GIN-POLE

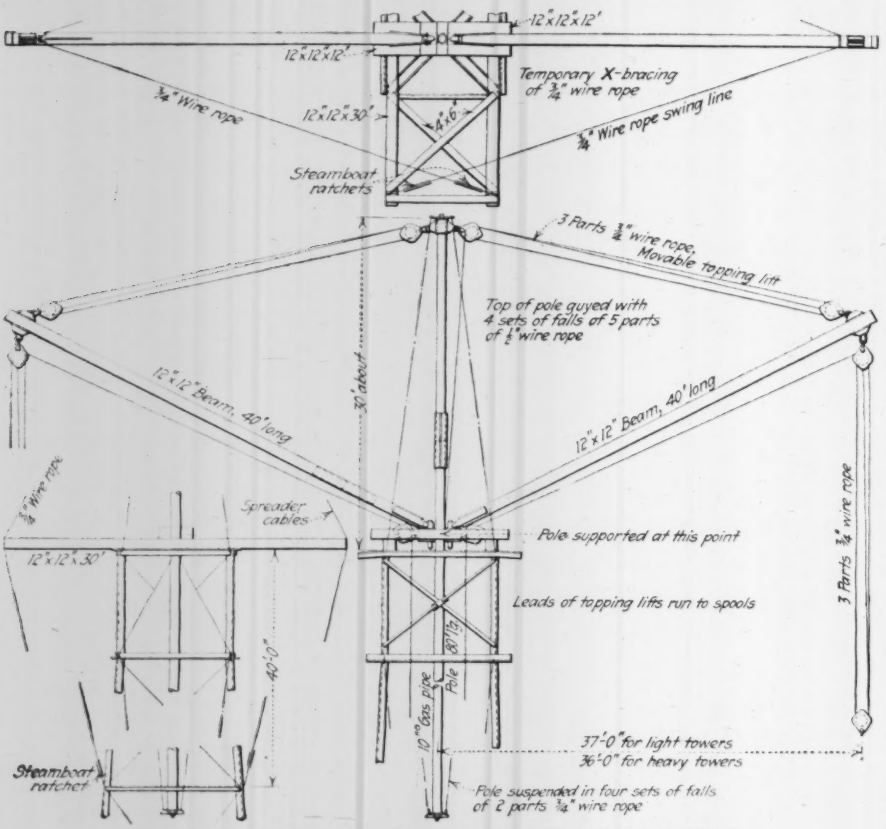


FIG. 6. TOWER-TOP RIGGING FOR ERECTING CROSS-ARMS

30 ft. below the horizontal strut. The load line consisted of a single part of ¾-in. wire rope, the lead running outside of the pole.

All steel for the body of the tower was hoisted outside of the tower. In the lower portion of the tower the pole was leaned over, without load, to the proper tilt, and the steel while being raised to place was outhauled with manila-rope tag lines. However, in the upper portion of the tower it was necessary to lean the pole farther over the side of the tower than its final position called for, in order to reduce the amount of outhauling, and then, after hoisting the steel, boom up the pole with the winches before connecting. The top of the pole was very easily controlled by the upper falls and the four winches and it could be placed wherever desired.

In erecting the first six panels the tower legs were erected singly and the bracing in panels. In the upper five panels, where the steel was lighter in weight, two tower legs and a panel of bracing bolted to it were erected at one time. Where a panel of bracing alone was erected, it was necessary in order to prevent injuring the lower diagonals to turn them up and tie them temporarily to the intermediate horizontal strut. The bracing in the horizontal plane which occurred at every other panel point (Fig. 3) was not erected until the foot of the gin-pole passed that point, thus avoiding interference of the bracing with the lateral movement and tilting of the pole.

The heaviest pieces in the body of the tower were 3,400 lb., but the heaviest lift was 4,850 lb., which consisted of two legs and bracing of the fourth section below top of tower.

No elevator was provided for the men, but they used the permanent ladder for climbing up the tower; the men were able to climb from the ground to the cross-arm in ten minutes. Signals were given by megaphone, which proved more satisfactory than electric bell signaling. As the tower was not riveted until completely erected, the members had to be well connected with plenty of drift-pins and bolts as the erection proceeded.

Raising the Floating Gin-Pole.—After erecting a complete panel of tower the floating gin-pole had to be raised vertically about a panel height. But before this could be done, the sheave blocks of the upper and lower falls, fastened to the tower at a panel point, had to be raised to the next higher panel point and fastened to the tower as before. For this purpose the pole would be well leaned over to one corner of the tower and, while three sets of upper falls held the top, the block of the fourth or slack set of falls would be unfastened from the tower. The lead line of this falls would then be wound up on its winch, thus shortening the length of the falls and raising the block to the next panel point where it would be fastened to the tower. Then the block of the lower falls at the same corner would be raised, but as this set of falls was necessary to hold the pole in inclined position, it had first to be temporarily replaced by a

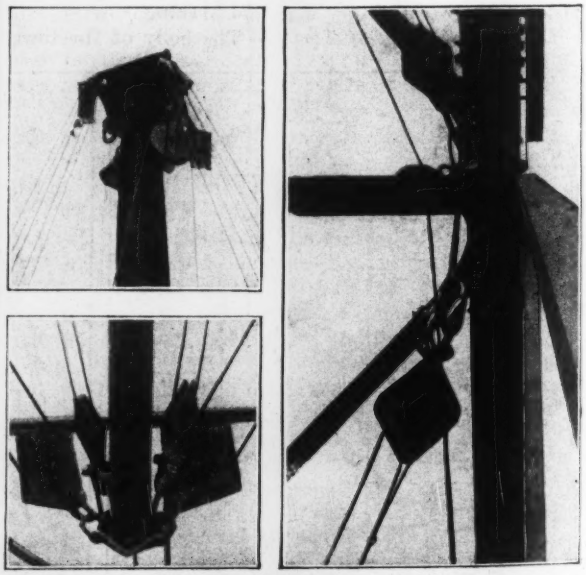


FIG. 5. SUPPORTS AND FASTENINGS OF FLOATING GIN-POLE

manila rope falls, after which the block of the lower falls was unfastened from the tower and by means of the load line of the floating pole was then raised to the upper horizontal strut as the lead of the falls was let out and the lower falls lengthened. When this raising of upper and lower falls was completed the pole would be leaned over to the other corners in succession and the operation repeated. The pole would then be placed in a vertical position and raised about 30 ft. by shortening the lower falls through winding their leads on the spools of the engine while the top guys were being let out, and the leads of the lower falls finally were clamped to the spools. The average time required to shift falls and raise the pole was fifty minutes.

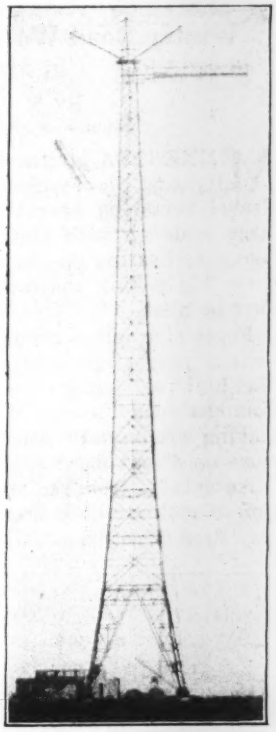


FIG. 8. HOISTING A HALF CROSS-ARM

The rigging of the floating gin-pole together with the method of erection as described is believed to be more adaptable to the type of tower erected than the rigging and methods which originated in the erection of three-legged towers with rod bracing, i.e., suspending the pole in cables of fixed lengths, raising the pole by one or more extra falls, hoisting the steel through the inside of the tower, and controlling the top of the pole from the tower top.

Erecting the Cross-Arm.—The cross-arm is 150 ft. long out to out and is composed of two sections 70 ft. long connecting to the sides of the tower, which itself forms 10 ft. of its length. The two half cross-arms weigh 8 tons each. A rather unusual and difficult problem was presented in their erection on account of their length and weight and the small working base.

While the cross-arm probably could be erected piece by piece by cantilever erection with a traveler working on each side of the tower, such method would be very costly and unsafe, particularly on account of the large number of small pieces and the difficulty of making connections at a considerable height from the ground. An original and unique method avoided these objections. It consisted of assembling the cross-arm in two sections on the ground, balancing them against each other, and raising first one and then the other to the top of the tower while maintaining the counterbalance. The method proved very practical and economical.

The rigging used for raising the sections of the cross-arm (Figs. 6 and 7) was essentially a two-boom guy derrick for which the floating gin-pole served as mast. The booms were 12 x 12 timbers 40 ft. long fitting into Chicago foot blocks resting on bearing plates fastened to two stringer timbers 12 ft. long. These timbers in turn were fastened to two 12 x 12 timbers 30 ft. long which were at right angles to the final position of the cross-arm and resting on the top of tower, which as stated is 10 ft. square. The booms were held fixed in position and in line with each other by swing lines running to the ends of the 30-ft. cross-timbers. The topping lifts consisted of three parts of ⅞-in. wire rope, and after the booms were set for the proper reach the leads of the topping lifts were clamped to the spools. The floating gin-pole, which acted as a mast, was suspended in the four lower falls and guyed at the top exactly as when erecting the body of the tower, but with additional guying by four spreader cables which passed over the ends of the 30-ft. cross-timbers. The load falls consisted of three parts of ⅞-in. wire rope. The timbers and booms with their rigging were placed and dismantled by the floating pole. The pole projected

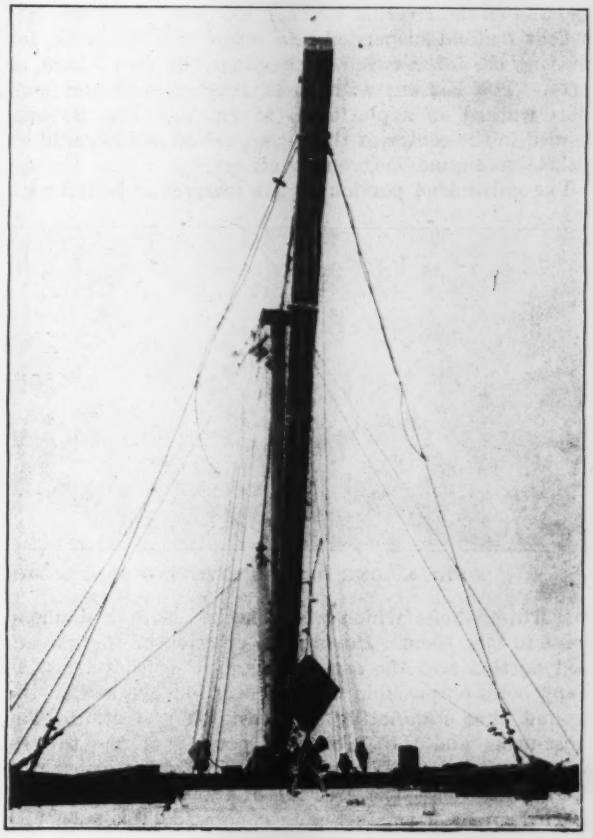


FIG. 7. BALANCED BOOMS ON TOWER TOP

about 30 ft. above the top of tower, while the front reach of the booms was about 36 ft.

Balancing the Cross-Arm Sections.—Each section of cross-arm was completely assembled and bolted by hand on the ground on its side of the tower at right angles to its final position. To avoid throwing an eccentric load on the tower and to prevent excessive unbalanced stresses in the floating pole and rigging, it was necessary when raising the cross-arm on one side of the tower that the effects of its weight be counterbalanced on the other side of the tower. This balance was obtained by simultaneously picking both sections clear of the ground, this throwing only a downward compressive force on the tower and equal loads on each boom. Then, while maintaining this relation, the section of cross-arm on one side was raised to the top of the tower (as the other section hung in the load falls close to the ground), turned at right angles by means of the tag lines, and

connected to the tower. Keeping the strain in this set of load falls, the other section of cross-arm was now raised (Fig. 8), turned and connected. Then the strains in both load falls were released and the rigging dismantled. The time spent in raising and connecting the two sections of cross-arm in calm weather was approximately four hours.

Riveting.—All rivets were ¾ in. in diameter. Air was furnished by a cross-compound pump, the compressed-air outfit being placed at every third tower and the air piped to the adjacent towers. An L-shaped scaffold was used for riveting the columns. It was suspended from a small set of falls so that the scaffold could be lowered by hand as the riveting was carried down the tower leg. A float scaffold suspended in a set of falls was used for riveting the intersection of the diagonals (see Fig. 9, at left). The heaters with their forges, tools and supplies worked on a platform (at right in Fig. 9) suspended in the center of the tower, raised and lowered by a skeleton engine operated by air.

The galvanized portion of the tower was bolted with

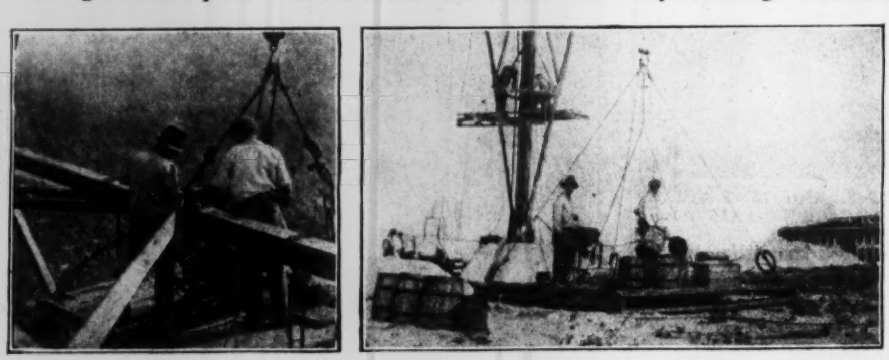


FIG. 9. ONE OF THE RIVETING STAGES—HEATERS' FLOAT

sherardized bolts which were checked with a diamond point to lock them. During the erection of the galvanized portion and the assembling of the cross-arms, as many bolts as possible were placed and checked on the ground, thus eliminating this work after erection. The cross-arms and the galvanized portion of the towers, which were bolted, formed a very rigid structure.

Organization.—The erection of the tower proper was carried on by a raising gang composed of a pusher, a hoisting engineer and thirteen bridgemen, five of whom were stationed on top. When raising the floating pole, four of the ground men were assigned to the winches and the other four to the spools of the engine. The average time required to erect the steel of one tower was 18 days and the best record made was 14½ days. Three towers were erected at one time.

The cross-arms were assembled on the ground by a separate gang some time in advance of their erection. The finishing of the erected cross-arms and the bolting of the towers was done by another gang. A tower was not riveted until completely erected, but the riveting was carried on during the erection of the other towers.

Very few men were hurt on the work and all injuries were of a minor nature.

The towers were designed by the tower department of the American Bridge Co., fabricated at the company's Ambridge plant and were erected by the Eastern Division erecting department, of which J. B. Gemberling is manager. Jerry Kennedy was foreman of erection in the field and the writer was resident engineer.

Winter Road Work Proving Successful in Minnesota

BY E. M. RICHTER
Minnesota Highway Department

MINNESOTA is demonstrating both the practicability and the economy of winter highway work. Gravel surfacing operations are going forward on a large scale on both state and county projects; some heavy excavating is showing favorable progress, and three big paving contracts on the state trunk system have been let.

Foreseeing an unemployment situation of possibly serious proportions and anticipating action on federal aid highway legislation following prolonged delays, Commissioner Charles M. Babcock last August began making preliminary plans to continue highway operations on a maximum scale through the winter months.

An opinion from the attorney general that the collection of motor vehicle taxes accruing to the trunk highway fund might be anticipated, opened the way to match federal aid which was voted finally. Within ten days the Minnesota highway department announced a first list of winter work projects on the trunk system. It included approximately 300 miles of gravel surfacing, 50 miles of grading, and 50 miles of paved road.

That prospective contractors saw ways of cutting the costs of moving gravel by hauling on hard frozen roads and in many cases with sleds was evidenced by the low bids secured. Gravel surfacing figures averaged 23c. a yard-mile, and went as low as 17c. Three important concrete paving projects have also been let at low prices. Butler Brothers Building Co., St. Paul, was awarded the state job for 25 miles on trunk highway No. 1, between Westcott and Northfield at $2.26 a yard, with bar reinforcing and rock aggregate. McCree, Moos & Co. got the 22-mile project on T. H. No. 27 between St. Cloud and Royalton at $2.36 for the same type. An award remains to be made on the 10-mile extension between Royalton and Little Falls on which the low bids were $2.23 for bar reinforcement and gravel, and $2.40 for bar reinforcement and crushed granite.

The decision to let paving contracts followed inquiries which developed that much preliminary work could be done during the winter, including rock crushing and stockpiling. General Gustaf Widell, Mankato, an experienced builder, estimated that he could use fully one-fourth of his regular organization through the winter on any paving contracts awarded during November and December.

In addition to the state program comprising to date about $922,000 of winter graveling and grading, exclusive of paving projects, many "local team jobs" of gravel surfacing have been initiated both by state and country road authorities. In the extreme northwest section 388 farmers with teams were listed on the December payroll of the state district maintenance engineer covering special winter work on graveling operations. Traverse County on the west border

employed 367 men and teams to gravel state-aid roads under county supervision. J. H. Mullen, state highway engineer, predicts that barring extremely unfavorable conditions during the next two months, the Minnesota winter highway operations will be successful beyond expectations. The program has, it is stated, given employment to more than 7,500 men, who otherwise might have been jobless, according to the best available estimates.

Water Intake Protected Against Severe Conditions

Largest Traveling Screen Outfit in World—Pivoted Crane with Grab Bucket Removes Logs and Dirt from Deep Well

AN EXTREME water level variation of 71 ft. in the Ohio River, combined with an exceptional accumulation of debris, has led to the introduction of special plant for screening the water and removing the debris at the intake well of the West End power station of the Union Gas & Electric Co., at Cincinnati, Ohio. This plant includes the largest installation of traveling screens in the world, having sixteen screens 91 ft. high, and also a novel swinging crane for cleaning the well.

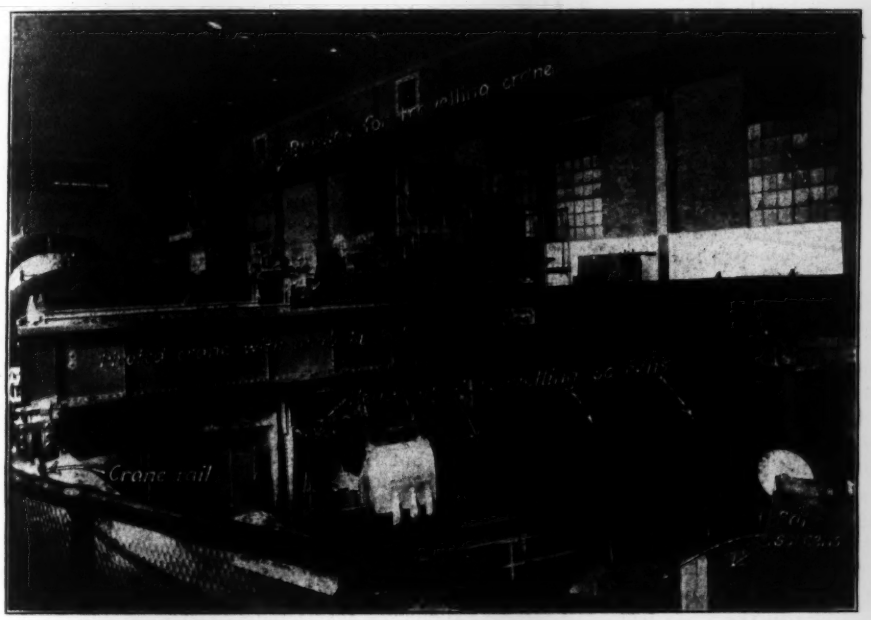


FIG. 1. PIVOTED CRANE WITH GRAB BUCKET FOR CLEANING INTAKE WELL

This equipment is shown in Fig. 1. Particulars of the intake well and tunnel, in connection with the foundation work of the station, were given in *Engineering News-Record* of Sept. 27, 1917, p. 593. With the four 30,000-kw. turbines in operation this station uses water at the rate of 208,000 gal. per minute.

At the power station site the river bed is rather contracted and the Licking River, entering the Ohio on the opposite side and above the station, deflects the debris toward the power station. In addition to the usual accumulation of leaves, boughs, straw and miscellaneous trash there are such large pieces as telephone poles, railway ties, logs and entire trees, besides which the water carries a large amount of mud and sand in suspension.

The intake tunnel, extending 164 ft. from the station, has its end entirely open, as it was feared that any grill would become blocked by logs and debris which could not be removed during high water and might thus put the station out of service. This tunnel is 25 x 10 ft. in section, with crossbraces about 10 ft. above the bottom. Its floor is 10 ft. below extreme low water and 5.7 ft. above the bottom of the intake well, 60 ft. in diameter. In spite of the well screens, a considerable amount of leaves, straw and mud found their way into the condensers. At numerous times it has been necessary to cut out a turbine to allow of cleaning the condenser, other stations then taking the load.

Original Screen Plan.—In the original arrangement, shown at the left in Fig. 2, screens or grills of vertical bars prevented the larger material from passing beyond the intake well. These grills had bars 3 x ½ in. spaced 2½ in. c. to c. Finer material passing the grills was caught on traveling screens, one for each unit, consisting of endless belts of ¾-in. mesh. These carried up the material to a trash trough, into which it was washed by water jets. Behind the traveling screens were vertical screens in 7-ft. movable panels, these being in duplicate, so that one panel could be removed for cleaning while the other was in service.

But with the tops of the traveling screens at the 34-ft. stage of the river any further rise of the water made it necessary to raise the panel screens, the space below them being then closed with blank or solid panels. This work required about seven hours, so that it was necessary to anticipate the river rise by several hours, removal of the screens being impracticable when the water rose above them. Several times the rise has been so rapid that all the screens could not be raised. With the blank plates in place they formed a pocket 40 ft. deep which filled with sand and debris. After the river fell, this had to be cleaned out before the screens could be lowered.

Removal of the vertical screen panels by means of electric hoists was such wet and disagreeable work that it was difficult to get men to handle it. If the men were not watched, they would fail to remove the lower panels, so that these became blanketed with dirt. Further, the dirt and trash sometimes accumulated so rapidly, in spite of the traveling screens, that the stationary screen panels could not be removed and cleaned fast enough. Under the high head of water the blocked screens sometimes buckled, requiring the service of a diver to get them out. Screen panels left in the lower position when the water rose above the 34-ft. stage were often found buckled when the water went down.

Improved Screen Plan.—These difficult and serious conditions led to a careful study which resulted in extensive changes in the screen system during 1921, as

will be seen from the drawing at the right of Fig. 2. Briefly, the single traveling screens were replaced by double traveling screens and the fixed screen panels were removed entirely. New grills with bars 4 x ⅜ in. spaced 3 in. c. to c. were set in the lower part of the openings, up to El. 452 (or river stage 23 ft.). Above this, some of the old grills were left but others were replaced with the new bars. The traveling screens were altered to make a closer fit with the frames and were lengthened to reach El. 502, making a total length of 91 ft., so that they will meet the conditions of flood stages in the river. To assist in cleaning the screens and intake well the floor above them, at turbine room level, was cut out and gangways were provided for maintenance and inspection of the screens.

For slush ice conditions, it is proposed to cut a connection from the discharge tunnel into the intake tunnel, which it parallels, so that the warm discharge water can be directed into the intake tunnel. This improvement has not been carried out as yet. A proposed system of water jets for cleaning the tunnel is to be investigated. This provides for three or four lines of 6-in. pipe laid on the floor and having ¾-in. jets about 3 ft. apart, inclined at about 45 deg. toward the well. These jets at 100 to 150 lb. pressure would be operated for about an hour daily. A further development would be the provision of two or three large jets in the river bed at the mouth of the tunnel in order to remove accumulations of mud and debris. This scheme has been used with success at the Licking River intake of the power house of the Covington & Cincinnati Street Railway Co., at Newport, Ky.

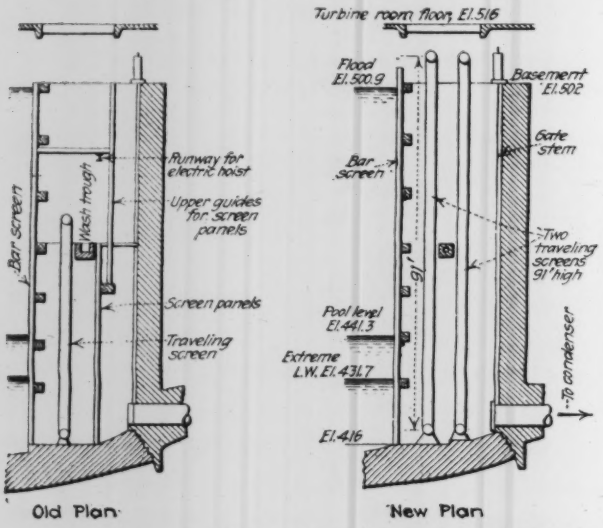


FIG. 2. OLD AND NEW SCREEN ARRANGEMENT IN INTAKE WELL

Cleaning the Intake Well.—For removing the accumulation of trash, logs and sand from the intake well, a grab bucket handled by a radial 5-ton traveling crane above the well was adopted after different plans had been considered. This crane swings on a vertical pivot at one side of the well and its outer end has wheels riding on a curved rail on the circular wall, as shown in Figs. 1 and 3. The span from pivot to rail is 49 ft. 10 in. and the vertical lift of bucket is about 100 ft. A ¾-yd. bucket is used, fitted with heavy teeth for gripping logs and other large obstructions. Two 7½-hp.

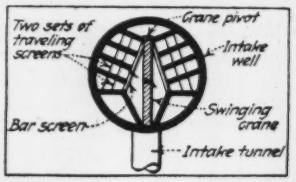


FIG. 3. PLAN OF SCREENS AND CRANE

motors operate the bridge and trolley travel and two of 45 hp. operate the bucket hoist. The crane covers the entire well and swings over a hopper having a discharge opening 4 x 6 ft., sufficient to carry off logs and other large pieces. These improvements were designed and carried out under the direction of C. W. DeForest, manager of the electrical department of the Union Gas & Electric Co., and Sargent & Lundy, Chicago, consulting engineers for the company. The new traveling screens were made by the Chain Belt Co., Milwaukee, Wis., and the pivoted crane by the Whiting Corporation, Harvey, Ill. Since the new installation was made there have been several bad river conditions, due to sudden rise of water bringing down great quantities of debris, but it is stated that these situations have been met without trouble.

The Average Engineer's Civic Duty

(Extract from paper by Prof. John H. Dunlap, president, Iowa Engineering Society, at Sioux City meeting Jan. 17 to 20, inclusive.)

HOW can the average, garden variety sort of engineer bring his training in applied science to bear upon the solution of the problems of the new era, for which his profession is so largely responsible? In Iowa the way is easy. In our principal cities our district clubs of engineers are meeting regularly and taking active interest in municipal affairs. These clubs are component parts of a strong state organization, which serves as a clearing house for the activities of clubs and seeks to render to the state the service for which the engineer is qualified. Moreover, our state organization is a member of the Federated American Engineering Societies. This is a comprehensive organization dedicated to the service of the community, the state and nation. In taking his part in public affairs, however, no engineer should think of his own selfish interest or reward. Each one of us should undertake to assist in the solution of at least one community problem, and give to it the best that is in him. In case the general public finds our service of value, whatever reward is attached to valuable service will naturally be ours. But the service must be first.

One plain duty of everyone is to initiate a plan, not in China or Africa, but right where he lives, which will gradually bring to pass a more intelligent and a more consecrated citizenship. As Theodore Roosevelt has said, the members of our communities should be graded not according to color, race, creed, wealth, education, family, but according to their performance of the duties of citizenship. To this end your attention is called to the booklet entitled, "A Plan for Unified Community Effort in American Citizenship," by Martin J. Wade, judge of the United States District Court. In brief, Judge Wade suggests a community council, representative of all patriotic and fraternal societies and clubs of the community, to meet at least monthly. Such a council could lay out a comprehensive program for a community and transform it in a generation into the best possible place in which to live, to build homes and rear children.

Second Simplon Tunnel Completed

On Dec. 4 the lining of the second Simplon tunnel, connecting the head of the Rhone valley in Switzerland, with the Italian slope of the Alps, was completed. Work had been in progress for nine years. It was not direct tunnel driving but enlargement work of the heading or ventilation tunnel which was driven at the time the first tunnel was put through. The tunnel is about 12½ miles long.

New Committees for Highway Research

AT ITS meeting in New York City Jan. 16, the Advisory Board on Highway Research approved the report of the Committee on Researches and Research Committees (Prof. T. R. Agg, chairman) as noted in the news section of this journal Jan. 19, p. 125. The report, which carries the title "Suggested Researches and Research Committees," indicates certain problems needing study and outlines the following program of activities:

I Committee on Economic Theory.

Problem: To determine all of the elements of cost of highway improvement.

The following will suggest the type of research involved:

A. Effect of grades, alignment, rise and fall, weather and speed and methods of operation on cost of transport.

B. Determination of all of the elements entering into the resistance to translation of vehicles (Tractive Resistance) and magnitude of each element.

C. Determination of the elements of cost of vehicle transportation classed as capital costs, and operating costs exclusive of those included in A and B.

D. To determine the relation between traffic and capital and maintenance costs of roads.

II. Committee on Structural Design of Roads.

Problem: To establish all of the data required for rational design of a road surface.

The following will suggest the type of research involved:

A. Determination of all facts relative to the behavior of the soil upon which roads are constructed, when under load from the road structure.

B. To determine the relation between traffic loads and stress in road surfaces, and to establish the laws that control.

C. To determine the effect of the elements on road structures.

D. To determine the structural strength of all types of road surfaces.

E. Relation of the vehicle to the road.

III. Committee on Road Materials.

Problem: To determine the most effective combinations of materials to give desired strength and to investigate possible new combinations of materials.

The following will suggest the type of research involved:

A. To establish the most effective combinations of materials now in use, with particular reference to the exigencies of field control.

B. To promote research looking to the establishment of new combinations of materials, or of the new materials suitable for road surfacing.

IV. Committee on Highway Traffic Analysis.

Problem: To establish an adequate method of studying highway traffic and to show how traffic records should be interpreted.

The following will suggest the type of research involved:

A. A study of relation of community development to the origin and destination of traffic, and to devise means for estimating potential traffic.

B. Proper methods for studying and recording volume of traffic, and for interpreting traffic records.

C. To devise units of measure to apply to traffic and to define those units.

D. To study the relation of highway betterment to traffic increases.

V. Committee on Highway Bridges.

Problem: To establish all of the data required for the design of highway bridges.

The following will indicate the type of research required:

A. Determination of loads for which bridges should be designed.

B. Study impact on highway bridges.

C. Determination of the proper requirements for standards of design as regards allowable stresses, widths and requirements of foundations.

VI. Committee on Highway Finance.

Problem: To determine the equitable basis for financing highway improvements.

The following will indicate the type of research involved:

A. Definition of an equitable basis for highway financing.

B. Study possible methods of financing improvements in the various political units.

C. Administrative methods required to insure equitable financing.

VII. Committee on Maintenance.

Problem: To determine the relation between traffic and maintenance costs of roads to investigate methods of maintenance and organization of maintenance forces.

The following will suggest the type of research involved:

A. Establishment of accounting methods that will give accurate data on cost of maintenance.

B. Methods of correlating maintenance costs and volume of traffic.

C. Relation of maintenance costs to methods of maintenance.

VIII. Committee on Subgrade.

Problem: To determine the supporting power of soils under all conditions; to investigate methods of increasing the stability of subgrades and to consider any similar problems having to do with the characteristics of subgrades.

Committees VII and VIII were added to this report at the suggestion of the Director of Highway Research and have not been considered by the entire Committee on Research, due to the lack of time for the necessary correspondence. If these are constituted, the field of Committees I and II should be modified so that no overlapping exists.

It is believed that the results of the work of the six committees suggested herein will show the need for investigational committees on Vehicle Design and Construction Methods, but the establishment of such committees is not recommended at this time.

Experience with Creosoted Piles

The practice of steaming piles and timbers as a part of the creosoting process is not approved or followed on the Atchison, Topeka & Santa Fe Ry. It is found to lead to irregular penetration of the oil, according to a recent paper by A. F. Robinson, bridge engineer of the railway. Examinations of old treated piles which had been subjected to steaming showed that the thickness of the treated shell might be from that of a mere skin to a thickness of 2 in., the thickness varying all around the pile. This irregularity was considered due to moisture in the piling as a result of steaming and improper seasoning. When the railway opened its own treating plant at Somerville, Tex., in 1907, all the material was carefully air cured and no steaming was done. In this way a very uniform penetration has been obtained. In Mr. Robinson's opinion different rules for air curing will be required in sections having varying moisture conditions.

Where damaged creosoted piles were found in trestles, they were cut down to solid wood and the heads then covered with three or four coats of hot creosote mixed with heavy road oil. A sheet of prepared roofing was placed on each head and a framed bent of creosoted timber was set in place, being drift bolted to the short piles. It was found that decay was sure to start promptly where the men chamfered pile heads at the cap for drainage, bored holes for sway brace bolts or trimmed the pile faces to make the sway brace planks draw straight.

Live-Loads for Motor-Truck Storage

Amount and Distribution of Weight in Trucks of Different Sizes and Makes—Grouping of Wheels Producing Maximum Floor Stresses—Equivalent Uniform Loads

By E. L. Verveer
Structural Engineer, New York City

STORAGE buildings and garages for commercial vehicles present a special problem because of the high concentrations involved, the variation of weights and dimensions of trucks, and the variable grouping of the loads on the floors. A study of these variables is presented in the following, based on the data of some 45 different makes of truck. It is intended to apply only to floors of slab-and-beam construction, but covers all sizes of modern motor truck up to 6 tons capacity.

In its effect on the floor itself, or the slab, a truck wheel is practically a point load. With respect to the supporting beams and girders, while the load might be considered distributed over the width of the tire, no material error is introduced by assuming the wheel loads concentrated. The actual distribution to the floor framing depends upon the style of construction employed. In a monolithic floor, the wheel loads will deploy more uniformly than where the floor is merely supported by independent members.

Motor-truck load comprises chassis weight, superimposed body weight, and weight of the maximum carrying load (pay load). The chassis weight is a definite quantity, depending upon the type and make of truck. The same is true of the pay load, but the body weight depends upon the use to which the truck is to be put. The chassis length of any particular make for a specified capacity often varies, depending in a measure upon the type of body. This variation in chassis length occurs in the loading space, that is, the distance from the back of the driver's seat to the rear end of the frame. The length from the center of the rear axle to the rear end of the body will also vary from a minimum for a dump-body to a maximum for other styles. Although the chassis weight for any particular capacity will increase with its length, this increase is very small and not large enough to influence the calculations materially.

Body and Chassis Weight.—To avoid overloading the chassis when the full pay load is applied, the maximum body weight for a given truck is limited. For the sake of uniformity, the National Automobile Chamber of Commerce in 1912 adopted the standard body-weight allowances given in Table I. These weights were used by the majority of truck makers up to the past year, when they were revised to the weights shown in the third column of Table I. These weights are in common use, or in any case they will not differ much from the weights of actual truck bodies.

TABLE I—STANDARD BODY-WEIGHT ALLOWANCES
(National Automobile Chamber of Commerce)

Capacity Tons	Standard Body Weight, Lb. Old Std.	New Std.
¾	750	1,200
1	900	1,200
1½	1,050	12,00
2	1,200	1,500
2½	1,350	15,00
3	1,500	2,000
3½	1,600	2,000
4	1,700	2,000
5	1,800	2,500
6	1,900	25,00
7	2,000	25,00

For information furnished by the leading truck manufacturers, chassis weights are found to range as listed in Table II.

Weight Distribution.—From 45 to 60 per cent of the chassis weight is carried by the rear tires, the average being 55 per cent. The percentage should be assumed at 60 when not known. In most cases, 80 per cent of the body weight is borne by the rear axle, but quite frequently this percentage may be as low as 60 or as high as 100. If not known, not less than 90 per cent should be used for purposes of floor-load computations. The pay load is distributed in the same proportion as the body weight. The portion of the combined chassis and body weights carried by the rear tires varies from 52 to 66⅔ per cent for different makes. It is about 60 per cent for 3½-ton trucks and under and 66⅔ per cent for those over 3½-tons capacity. When the actual amount is not given, it is advisable to assume it at 66⅔ per cent.

TABLE II—WEIGHTS OF COMMERCIAL CHASSIS
(Data from Manufacturers)

Truck	Range, Lb.	Average Lb.
1-Ton	3,000—4,600	3,500
1½-Ton	3,400—5,000	4,200
2-Ton	3,800—5,500	4,800
2½-Ton	4,200—6,000	5,000
3-Ton	5,400—7,500	6,200
3½-Ton	6,400—8,100	7,000
4 -Ton	7,200—8,100	7,600
5- Ton	7,500—9,300	8,800
5½-Ton	8,500—8,750	8,700
6- Ton	8,500—9,600	9,200

When a truck is fully loaded, the rear tires support from 58 to 80 per cent of the total load, depending upon the make of truck, but for use in practice 75 per cent of the total weight (chassis, body and pay load) is a good value to use for normal conditions of loading.

Total Weight.—Table III gives the range and average of combined chassis, body and pay load for trucks of different capacities, according to data furnished by the makers. Table IV gives dimensions and weights for standard trucks of typical makes.

TABLE III—LOADED WEIGHTS OF COMMERCIAL TRUCKS

Truck	Range, Lb.	Average, Lb
1- Ton	5,400— 6,800	6,400
1½-Ton	7,300— 9,300	8,200
2- Ton	9,000—11,000	10,300
2½-Ton	10,500—12,500	11,300
3- Ton	12,800—15,200	14,000
3½-Ton	14,300—17,100	15,600
4- Ton	17,000—17,600	17,500
5- Ton	19,300—21,700	20,600
5½-Ton	21,200—21,700	21,300
6- Ton	22,400—24,000	23,600

The upper floors of a garage, that is, those above the first or ground floor, are very seldom called upon to sustain any pay load. The live loads to be used for the design of such floor systems are, therefore, those derived from the chassis and body weights only. Where ramps are employed, impact should be included.

The ground floor usually rests upon the soil, but for cases where there is to be a basement, necessitating an independent floor system, both impact and pay load should be provided for, as loaded trucks are often driven into the first story.

The loading diagrams used to compute the bending moments, shears, etc., are shown in Fig. 1 herewith. The second column represents the rear axles of two trucks placed side by side, the third column the rear wheel of one truck and the front wheel of another directly behind it, the fourth column the rear wheels of two trucks back to back.

Floor-Beam Stresses—Ordinarily trucks are placed parallel or at right angles to the floor beams. Investiga-

tion of both arrangements will show that the maximum conditions of loading occur when the trucks are at right angles to the floor beam and the axles directly over and parallel to the beam. The maximum bending moment may then be obtained by applying as many multiples of the loading diagram in Fig. 1 (Col. 2) as can be placed on the beam and at the same time fulfill the criterion for maximum bending moment. The same method applies to finding the shears.

Tables V to VIII inclusive give the maximum bending moments, equivalent uniform loads, maximum end shears, and concentrations, for beams of 15 to 30 ft. span, for trucks of 1, 1½, 3½ and 5 tons capacity. The corresponding data for 2 and 2½-ton trucks may be obtained by proportion from Table VI, those for 3 and 4-ton trucks in the same manner from Table VII, and those for 6-ton trucks from Table VIII.

The coefficients K, Z and E, if multiplied by the rear wheel load P_R, will give the bending moment M, equivalent uniform load W, and beam concentration R, respectively. These coefficients are given so that, in case it is desired to substitute different values for P_R from those used in the tables, the corresponding values of M, W and R may readily be obtained. These tables apply to simply supported beams. For any other assumption of the supports, the maximum bending moments and shears may be found by proportion; the values of W, however, will not change.

For the maximum end shears (Col. 6) the first wheel is placed 9 in. from the center of the beam support for 1 to 2½-ton trucks, and 1 ft. for those of 3 to 6-ton capacity. Allowing for the flattening of the tire and the width of the supporting girder, such assumptions seem reasonable. Fig. 2 shows a typical diagram of maximum shears at various points on a beam when the loads move off from left to right, which is the same as assuming the beam partially loaded. Approximate working quantities for these shears may be found from the equations $V = V_m x^2/(l - 0.75)^2$ for 1 to 2½-ton trucks, and $V = V_m x^2/(l - 1)^2$ for the others, where V is the maximum shear at distance x from the right support, l is the length of the beam, and V_m is the maximum end shear. For rolled steel sections the end shears are ordinarily sufficient, but for reinforced-concrete or built-up steel beams the maximum shears at various points are required in order to provide proper diagonal

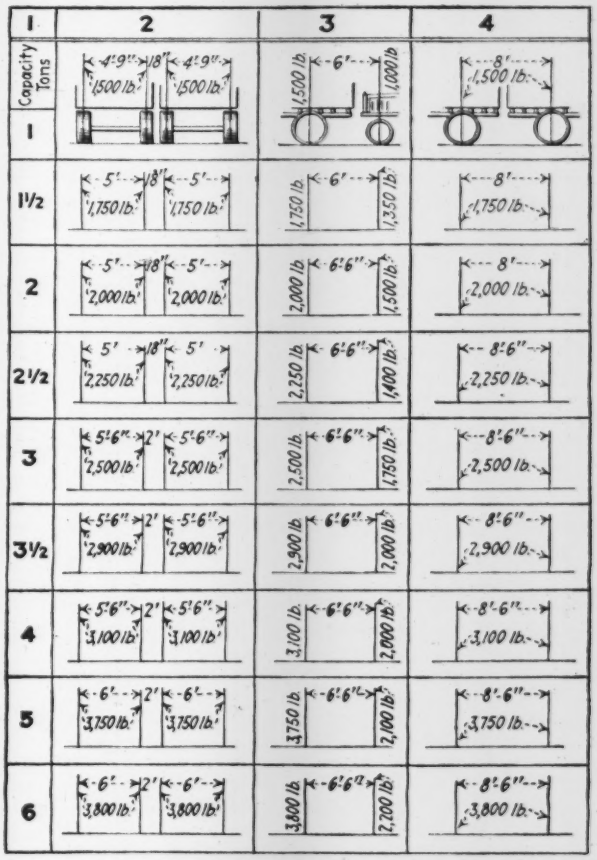


FIG. 1. LOADING DIAGRAMS FOR TRUCK STORAGE

TABLE IV. DIMENSIONS AND WEIGHTS OF TYPICAL TRUCK

Capacity, Tons	Overall Length L Ft.	Overall Length L In.	Overall Width W Ft.	Overall Width W In.	Front Tread A Ft.	Front Tread A In.	Rear Tread B Ft.	Rear Tread B In.	Wheel Base C Ft.	Wheel Base C In.	Rear Tire T In.	Chassis and Body Weights Combined: Front Axle Lbs.	Chassis and Body Weights Combined: Rear Axle Lbs.	Chassis and Body Weights Combined: Total Lbs.	Chassis, Body and Pay Load Combined: Front Axle Lbs.	Chassis, Body and Pay Load Combined: Rear Axle Lbs.	Chassis, Body and Pay Load Combined: Total Lbs.
1	16	7	5	11	4	10	4	10	11	5	5	1,942	2,428	4,370	2,102	4,268	6,370
	16	2	5	8½	4	8	4	10	10	8	4	1,700	3,100	4,800	2,095	4,705	6,800
1½	18	8	5	9	4	8	4	8	11	8	5	1,570	2,700	4,270	2,170	5,100	7,270
	18	1	6	1	4	10½	4	10½	12	0	6	2,730	3,570	6,300	2,690	6,610	9,300
2	17	10	5	9½	4	9	4	11½	11	11	6	2,020	3,000	5,020	2,240	6,780	9,020
	18	1	6	1	4	10½	4	10½	12	0	7	2,600	3,800	6,400	3,000	7,400	10,400
2½	17	3	6	2	4	10	4	10	12	8	7	2,345	3,480	5,825	3,225	7,600	10,825
	18	8	6	2	5	0	5	1	12	6	8	2,700	4,100	6,800	3,110	8,690	11,800
3	17	11	5	10	4	8	4	8	10	4	6	2,700	4,122	6,822	5,460	7,362	12,822
	20	2	7	0	5	4	5	4	13	6	9	3,000	4,700	7,700	3,600	10,100	13,700
3½	21	9	7	2½	5	6½	5	5½	14	6	10	3,500	4,200	7,700	4,900	9,800	14,700
	18	10	7	0½	5	8½	5	11½	13	0	10	4,625	5,345	9,970	5,795	11,175	16,970
4	19	7	7	4	5	7	5	7	13	0	10	3,550	5,910	9,460	4,430	13,030	17,460
	23	7	7	4	5	7	5	7	15	6	12	3,550	6,020	9,570	4,430	13,140	17,570
5	20	6½	7	5½	5	6	6	2½	13	4	12	3,616	5,684	9,300	4,818	14,482	19,300
	26	9	7	7½	5	8	5	4	17	0	13½	4,110	7,590	11,700	4,550	17,150	21,700
5½	18	10	7	7	5	8½	6	2½	13	0	12	4,730	5,820	10,550	6,560	14,990	21,550
	22	10	7	7	5	8½	6	2½	15	0	12	4,715	5,985	10,700	6,305	15,395	21,700
6	18	1½	7	5½	5	7½	6	1	10	8	14	4,025	7,225	11,250	5,630	17,620	23,250
	23	7	7	4½	5	9½	5	9½	15	6	14	3,950	7,605	11,555	5,505	18,050	23,555

tension reinforcement or web thickness and rivet spacing.

The maximum beam concentration R is the maximum load on the floor girder from the two beams of equal length framing into it, one on each side. These concentrations can be used for designing the girder. Since the total load computed from the unit load W does not differ much from the actual value of R, the same uniform live load can be used for the girders as for the beams.

As will be seen from Fig. 1, when the distance between beams, or panel width, exceeds 6 ft. for 1 and 1½-ton trucks, and 6½ ft. for the others, a part of the loads from the front axle of the next truck will be transferred to the beam carrying a set of rear wheels. Similarly when the panel is 8 ft. to 8½-ft., a portion of an adjacent rear-axle load may be transferred. Although it is possible that these additional load increments will be brought to the beam as uniformly distributed increments, it is on the safe side to assume them as concentrated. Then, if the panel width is 7½ ft. for example, and the trucks are of 3½-tons capacity, the total wheel concentration on the beam to be designed will be

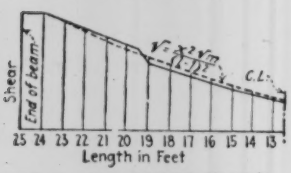


FIG. 2. MAXIMUM FLOOR-BEAM SHEARS FOR 25-FT. SPAN

$$2{,}900 + \frac{2{,}000}{7.5} \times 1 = 3{,}167 \text{ lb.}$$

When great accuracy is not required, the average uniform load per foot of beam, found at the foot of Column 5, or the average equivalent shear load per foot of beam at the bottom of Column 6, may be used irrespective of beam length. Dividing these loads by the panel width will then give the live load per square foot for bending moment and shear respectively. These average equivalent unit live-loads are given in Table IX.

The tests available at the present time from which to obtain practical working rules for the design of the floor itself are those of Prof. C. T. Morris (Ohio State Highway Dept., Bulletin No. 28), and W. A. Slater, E. B. Smith, E. B. McCormick and A. T. Goldbeck (Proc. Am. Soc. Testing Materials 1913; Am. Concrete Inst. 1915, 1916, 1917). All the tests were made on reinforced-concrete slabs, but from tests made on small models of heavy cardboard and wood the writer is convinced that the general conclusions reached by Goldbeck and other investigators apply also to other homogeneous material used in floor construction.

In general, it was found that when a concentrated load is placed in the center of a slab supported on two

MAXIMUM BENDING MOMENTS, EQUIVALENT UNIFORM LOADS, MAXIMUM END SHEARS, AND CONCENTRATIONS FOR BEAMS OF 15 TO 30 FT. SPAN, FOR 1, 1½, 3½ AND 5-TON TRUCKS

TABLE V—1-TON TRUCK

Dead Weight Pf on Front Wheel 1,000 Lb.
Dead Weight Pr on Rear Wheel 1,500 Lb.

1 Length c. to c. of Supports	2 Values of K (M=KPr)	3 Maximum Mom. M Foot-Lb.	4 Values of Z (W=ZPr)	5 Equivalent Uniform Load W Lb. per Lin. Ft.	6 Maximum Shear Vm Lb.	7 Values of E (R=EPr)	8 Maximum Beam Concentrations R Lb.
Ft.							
15	9.4	14,100	0.334	501	4,300	4.7	7,050
16	10.8	16,200	0.338	506	4,650	5.22	7,850
17	12.3	18,450	0.341	511	4,900	5.5	8,250
18	13.7	20,550	0.338	507	5,150	5.764	8,650
19	15.3	22,950	0.339	509	5,300	6.04	9,050
20	16.77	25,150	0.335	503	5,550	6.437	9,650
21	18.27	27,400	0.331	497	5,800	6.8	10,200
22	18.81	28,200	0.328	491	6,050	7.1	10,650
23	21.57	32,350	0.326	489	6,350	7.41	11,100
24	23.3	34,950	0.324	486	6,550	7.7	11,550
25	25.45	38,200	0.326	489	6,800	8.0	12,000
26	27.44	41,150	0.325	487	7,000	8.346	12,500
27	29.56	44,350	0.324	487	7,250	8.685	13,050
28	31.76	47,650	0.324	486	7,500	9.018	13,550
29	34.29	51,400	0.326	489	7,750	9.327	14,000
30	36.8	55,200	0.327	491	8,000	9.617	14,400
Average			0.330	(552)			

TABLE VI—1½-TON TRUCK

Dead Weight Pf on front Wheel 1,350 Lb.
Dead Weight Pr on Rear Wheel 1,750 Lb.

1 Length c. to c. of Supports	2 Values of K (M=KPr)	3 Maximum Mom. M Foot-Lb.	4 Values of Z (W=ZPr)	5 Equivalent Uniform Load W Lb. per Lin. Ft.	6 Maximum Shear Vm Lb.	7 Values of E (R=EPr)	8 Maximum Beam Concentrations R Lb.
Ft.							
15	9.04	15,800	0.321	562	4,900	4.7	8,200
16	10.29	18,000	0.322	563	5,250	5.031	8,800
17	11.80	20,700	0.327	572	5,550	5.324	9,300
18	13.30	23,300	0.328	575	5,850	5.583	9,800
19	14.78	25,850	0.328	573	6,050	5.87	10,300
20	16.29	28,500	0.326	570	6,300	6.175	10,800
21	17.79	31,100	0.323	565	6,550	6.5	11,400
22	19.29	33,750	0.319	558	6,800	6.818	11,900
23	20.85	36,500	0.315	552	7,150	7.152	12,500
24	22.57	39,500	0.314	549	7,450	7.437	13,000
25	24.41	42,700	0.312	547	7,700	7.72	13,500
26	26.48	46,350	0.313	548	7,950	8.0	14,000
27	28.47	49,800	0.312	547	8,150	8.37	14,650
28	30.45	53,300	0.311	544	8,450	8.66	15,150
29	32.70	57,200	0.311	544	8,750	8.983	15,600
30	34.94	61,150	0.311	544	9,050	9.283	16,250
Average			0.318	557	(625)		

TABLE VII—3½-TON TRUCK

Dead Weight Pf on Front Wheel 2,000 Lb.
Dead Weight Pr on Rear Wheel 2,900 Lb.

1 Length c. to c. of Supports	2 Values of K (M=KPr)	3 Maximum Mom. M Foot-Lb.	4 Values of Z (W=ZPr)	5 Equivalen Uniform Load W Lb. per Lin. Ft.	6 Maximum Shear Vm Lb.	7 Values of E (R=EPr)	8 Maximum Beam Concentrations R Lb.
15	7.97	23,100	0.283	820	7,150	4.0	11,600
16	8.97	26,000	0.28	812	7,450	4.312	12,500
17	10.00	29,000	0.277	803	7,850	4.588	13,300
18	11.26	32,650	0.278	806	8,200	4.889	14,200
19	12.53	36,350	0.278	806	8,700	5.158	14,950
20	14.08	40,800	0.281	815	9,100	5.4	15,640
21	15.6	45,250	0.283	820	9,450	5.643	16,350
22	17.0	49,300	0.281	815	9,900	5.886	17,050
23	18.57	53,850	0.280	812	10,200	6.109	17,700
24	20.0	58,000	0.278	806	10,550	6.437	18,650
25	21.56	62,500	0.276	800	10,950	6.72	19,500
26	23.0	66,700	0.272	789	11,300	6.981	20,250
27	25.2	73,100	0.277	803	11,800	7.26	21,050
28	26.45	76,700	0.27	783	12,250	7.5	21,750
29	28.51	82,700	0.271	786	12,600	7.759	22,500
30	30.73	89,100	0.273	792	12,950	8.0	25,200
Average			0.2775	804	(896)		

TABLE VIII—5-TON TRUCK

Dead Weight Pf on Front Wheel 2,150 Lb.
Dead Weight Pr on Rear Wheel 3,750 Lb.

1 Length c. to c. of Supports	2 Values of K (M=KPr)	3 Maximum Mom. M Foot-Lb.	4 Values of Z (W=ZPr)	5 Equivalent Uniform Load W Lb. per Lin. Ft.	6 Maximum Shear Vm Lb.	7 Values of E (R=EPr)	8 Maximum Beam Concentrations R Lb.
15	7.6	28,500	0.27	1,013	9,000	3.8	14,250
16	8.56	32,100	0.267	1,003	9,400	4.0	15,000
17	9.53	35,700	0.264	990	10,100	4.235	15,900
18	10.55	39,550	0.26	977	10,200	4.556	17,100
19	11.84	44,400	0.262	983	10,600	4.842	18,150
20	13.04	48,900	0.261	978	11,250	5.1	19,125
21	14.57	54,600	0.264	990	11,800	5.333	20,000
22	16.07	60,250	0.265	996	12,300	5.545	20,800
23	17.57	65,900	0.266	997	12,700	5.783	21,700
24	19.06	71,500	0.265	993	13,100	6.0	22,500
25	20.56	77,100	0.263	986	13,500	6.28	23,550
26	22.25	83,400	0.263	986	14,000	6.534	24,500
27	23.57	88,400	0.259	970	14,450	6.813	25,550
28	25.00	93,750	0.255	957	15,000	7.071	26,500
29	26.82	100,600	0.255	957	15,800	7.31	27,400
30	28.48	106,800	0.253	949	16,000	7.533	28,250
Average			0.262	983	(1,115)		

(NOTE: Value of V_m at foot of column 6 is the average load perlin.ft. of beam to produce max. end shear.)

TABLE IX. EQUIVALENT UNIT LIVE-LOADS (LB./SQ.FT.) FOR BEAMS AND GIRDERS

Capacity, Tons	Span 5		—5½—		—6—		—6½—		—7—		—7½—		— 8 —	
	Wm	*Ws*	*Wm*	*Ws*	*Wm*	*Ws*	*Wm*	*Ws*	*Wm*	*Ws*	*Wm*	*Ws*	*Wm*	*Ws*
1	99	110	90	100	83	92	78	87	74	83	71	79	67	75
1½	111	125	101	114	93	104	91	102	88	99	86	96	83	93
2	127	143	116	130	106	119	98	110	96	108	93	105	91	102
2½	143	161	130	146	119	134	110	124	107	120	103	116	100	112
3	139	155	126	141	116	129	107	119	104	116	101	113	98	109
3½	161	179	146	163	134	149	124	138	120	134	117	130	113	126
4	172	191	156	174	143	159	133	148	129	143	125	139	121	134
5	197	223	179	203	164	186	151	171	146	166	141	160	135	153
6	199	226	181	205	166	188	153	173	148	168	143	162	138	157

Wm for bending moment. *Ws* for shear.

parallel sides, the stress produced is distributed over a width, parallel to these two sides, equal approximately to twice the distance between supports. In other words, if the span of the slab is called S, the deflection at a distance S on either side of the load is practically zero, indicating that the effect of the load extends only over a distance of $2S$. The stress immediately under the load is greatest, and at a distance equal to S, measured on either side of the load, it becomes practically zero. The "effective width" is the width over which the concentrated load may be considered as uniformly distributed. This width, it was found, is changed very little by the percentage of reinforcement in the case of concrete, and is apparently independent of the magnitude of the concentrated load. It varies but slightly with the thickness of the slab.

Prof. Morris deduced the following equation for the effective width: $e = 0.6S + 1.7$ ft. This equation is applicable where the total slab width exceeds $1\frac{1}{4}S$ plus 4 ft. and was derived for use in highway bridge floor design. Mr. Slater suggested the equation $e = 0.8S + T$ for a load at the center and $e = 0.53S + T$ for two loads at the third-points, T being the width of the load, or in practice the tire width. From later tests, Goldbeck established a relation between the total slab width and the effective width from which he drew a curve

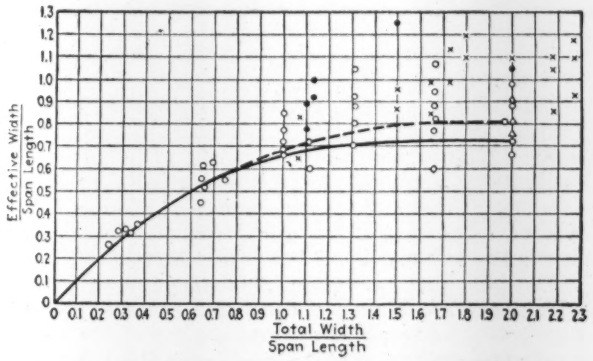


FIG. 3. CHANGE OF EFFECTIVE WIDTH OF SLAB WITH TOTAL WIDTH

shown in Fig. 3 by the full line. The diagram shows the plotted ratios obtained from the tests at hand; the writer would use, for floor slabs, the values indicated by the dash line in Fig. 3 and tabulated in Table XI. When the total slab width is equal to or more than twice the span lengths, the effective width e is approximately $0.8S$, and the formulas for rectangular beams may then be applied to the design of floor slabs by substituting $0.8S$ for the actual beam width b. Continuity of the slab does not change the effective width to any extent, merely changing the beam formula to be used.

In a building where the floor system is composed of beams and girders, excluding the long-span type of concrete construction, the length of the floor beams is usually greater than twice the span length. The equation $e = 0.8S + T$ can be applied in general to the design of the floor. The rear wheel loads are the ones to be used with the rear axle at right angles to the floor beams. The governing condition, in this case, is the maximum bending moment in the slab or arch. To illustrate the application of this equation, suppose the span length is 5 ft. and the floor is to support 1-ton trucks. Assuming each wheel load as extending over a length of 6 in. parallel to the supports, due to the flattening of the tire; $e = 0.8 \times 5 + 0.5 = 4.5$ ft. Each load of 1,500 lb. is to be considered uniformly spread over 4.5 ft. in the above direction. When e exceeds the

TABLE X. EQUIVALENT UNIT LIVE-LOADS (LB./SQ.FT.) FOR FLOOR SLABS

Truck Capacity, Tons	Span Ft. 4½	5	5½	6	6½	7	7½	8
1	225	185	155	145	135	125	115	105
1½	260	215	190	170	150	140	130	120
2	305	250	215	190	175	165	150	140
2½	345	290	240	215	190	180	170	160
3	335	285	245	220	190	175	165	155
3½	385	325	275	255	225	200	190	180
4	415	350	300	270	240	215	205	195
5	500	425	365	325	285	260	230	220
6	505	430	370	330	290	265	235	225

distances between wheels shown in Column 3, Fig. I, these latter lengths must be used.

Suppose, now, it is desired to use an equivalent uniform load per square foot of span length in place of the above concentrated load. Three cases, then, present themselves: floor slab with both ends supported, floor slab with both ends fixed (continuous slab), and floor slab with one end fixed and the other supported. Comparison of the bending moments from concentrated loads with those from equivalent uniformly distributed loads for these three cases, will show that practically the same unit load W_a for each capacity truck and span may be used in the three cases for application in the customary formulas for uniform loading. Table X shows the values W_a for floor slabs for spans 4 ft. 6 in. to 8 ft.

TABLE XI. RELATION BETWEEN SLAB RATIOS

Total Width, Span Length	Effective Width Span Length	Total Width Span Length	Effective Width Span Length
0.1	0.1	1.1	0.7
0.2	0.2	1.2	0.73
0.3	0.28	1.3	0.75
0.4	0.37	1.4	0.77
0.5	0.44	1.5	0.79
0.6	0.5	1.6	0.8
0.7	0.55	1.7	0.8
0.8	0.6	1.8	0.8
0.9	0.63	1.9	0.8
1.0	0.68	2.0	0.8

For general use the writer suggests the following live loads per square foot for the *beams* and *girders*: 1-ton trucks, 100 lb.; 1½-ton trucks, 115 lb.; 2-ton trucks, 125 lb.; 2½ and 3-ton trucks, 150 lb.; 3½ and 4-ton trucks, 175 lb.; 5 and 6-ton trucks, 225 lb. For the *floor slab*, these loads should be increased 50 per cent. For storage of trucks of mixed capacities, 125 lb., for 1- to 3-ton trucks and 200 lb. for the others are recommended, these loads also to be increased 50 per cent for the floor slab.

Sewage Screen and Pump Station at Pleasantville, N. J.

New Type of Rotary-Drum Fine Screens—Chlorination—Automatically Controlled Electric Drive for Both Screens and Pumps

By W. DeWitt Vosbury
Of Remington & Vosbury, Consulting Engineers, Camden, N. J.

IN designing works to treat the domestic sewage from the City of Pleasantville, N. J., fine screening followed by chlorination was adopted as the best solution of a difficult problem. The screens are of a new type and both screens and pumps are electrically driven, with automatic control.

Pleasantville is located on the edge of the mainland, approximately five miles from and due west of Atlantic City. Between the two cities there lies a tidal flat or meadow, dotted with ponds and transversed by a network of small, winding streams. The ground upon which the city is built averages but a few feet above the meadows.

VIEW OF ONE OF THE TWO FINE SCREENS AT PLEASANTVILLE SEWAGE-WORKS

A large tidal stream known as Beach Thorofare, and located on the opposite side of the meadows, immediately adjacent to Atlantic City, offered the only effluent point. This outlet was finally selected, although its adoption meant that all sewerage would have to be pumped a distance of some three and a quarter miles.

The depth of the sewer outlet below the surface of the marsh precluded the use of tanks in treating the sewage at that point, as, for obvious reasons, it would have been necessary to pump both to and from them. Furthermore, they could not have been placed at the terminus of the force main referred to above, as the location was inaccessible. The logical solution of this problem, and the one adopted, was the use of fine screens, followed by pumping, as owing to the limited space required by screens they could be placed at an elevation to receive the sewage by gravity.

The station consists of a rectangular building, superimposed upon a cylindrical shell, 30 ft. in internal diameter and 17 ft. deep. There are two floors. The first or motor floor is in reality a gallery which extends from the main entrance around three sides of the building to a stairway leading to the floor below. The second or screen floor is on a level with the outlet of the outfall sewer. With the exception of the dry well or pump pit, all of the space below this floor is used for the storage of screened sewage.

As the sewage enters the station, it flows through an open channel to the entrance of the chambers containing the fine screens, located on either side. After passing through the screens, the sewage returns to a point opposite the main channel, where it passes through an orifice opening into the storage well below. From the latter it is pumped to the outfall sewer.

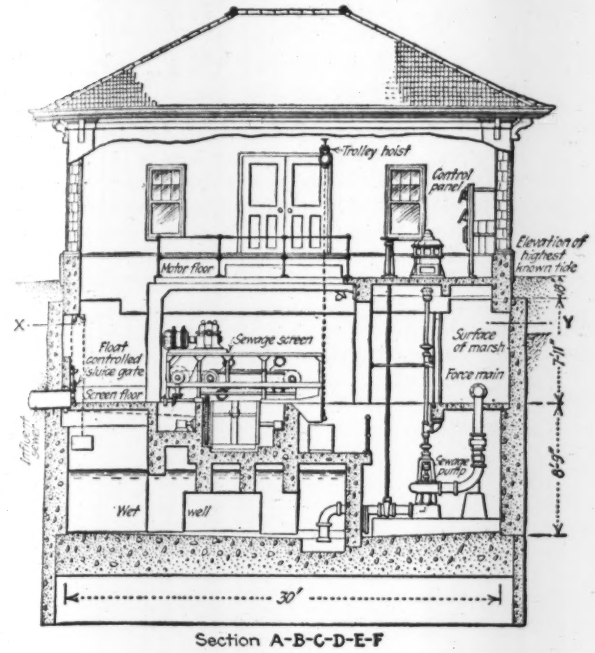
The mechanical equipment of the station consists of two motor-driven, centrifugal pumps, two fine screening units, auxiliary control and safety devices.

The pumps were built by the Buffalo Pump Co. and have a normal rated capacity of 1,000 gal. per minute. They are of the single-stage, bottom-suction, vertical-shaft type, with special sewage impellers. Experience gained by the writer in operating a number of sewage pumping stations has shown that frequent cleaning of the impellers is an essential of efficiency. For this reason each pump is provided with two openings, one in the shell and the other in the suction bend beneath. The cover plates for these openings are held in place by hand screws, which permit rapid removal and replacement. The pumps are driven by 20-hp. motors, mounted on the ground floor above. Besides the usual thrust bearings, built into the motors and pumps, a third thrust bearing, mounted beneath the motor floor, is used to support the dead weight of each vertical shaft.

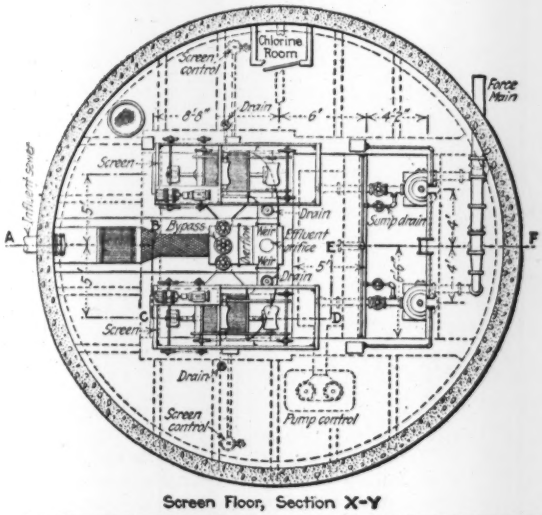
In determining the type of fine screen to be used, several points were carefully considered. The presence of mud, quicksand and large quantities of underground water made advisable the cylindrical form of the sub-surface structure and its construction by means of the open caisson method. The diameter of the shell, which was limited by cost and by the circular shape of the floor, restricted the space available for the screens to the minimum and, in turn, made the floor space they required an important feature. In addition, the station was designed to operate automatically, or at least without constant attendance. This meant that, besides being capable of producing a reasonable degree of clarification, the screens must be both rugged in construction and thoroughly reliable in operation. After a series of rigid tests, a new type of sewage screen, recently developed by the Link Belt Co., was adopted.

This screen is of the rotary drum type, with an ingenious mechanism for the removal of the solids collected. The screen proper consists of a cylinder or drum which revolves, partly submerged, in a concrete chamber at a circumferential speed of about 4 ft. per minute. The sewage enters from the outside and leaves the cylinder from the inside at one end.

The cleaning apparatus consists of four brushes which travel in a straight line, at a speed of approximately 38 ft. per minute, across the top of the revolving drum and parallel to its longitudinal axis. In addition to their motion of translation, the brushes also revolve about their own axis in such manner as to sweep the screenings in the direction of their path of travel into a chute, through which they fall to receptacles below. Removal of the solids in the sewage which do not adhere to the surface of the drum as it revolves out of the water is effected by a number of mechanically actuated sludge plates that project beyond the face of the drum, while rotating beneath the surface of the water, but which disappear as they are about to come in contact with the brushes.



Section A-B-C-D-E-F



Screen Floor, Section X-Y

PLAN AND SECTION OF PUMP AND SCREEN STATION

Each machine has a capacity of 1.5 m.g.d. and is driven by a 2-hp. variable-speed motor, although but approximately 1-hp. is actually consumed when operating under normal load.

These screens afford the means for an accurate comparison of two radically different types of screening surface. This difference consists in the fact that the drum of the one screen is covered with manganese bronze plates having $\frac{3}{64}$ x 2-in. slots on $\frac{1}{16}$ x 2½-in. centers, running parallel to the axis of the drum and in the direction of the travel of the brushes. The screening surface of the other machine is composed of stiff, phosphor bronze wires, mounted on a bronze frame, with $\frac{1}{32}$-in. openings or slots between.

The design of the latter type of screen followed a suggestion from the writer after a study of brush action in connection with various lengths of clots. In studying this action it was noted that the bristles of a brush in contact with the plate and when approaching a slot were slightly bent, and that as the slot was encountered, each bristle straightened out and entered with a downward motion. Although this motion was slight, the tendency at first was to push the finer particles which had collected over the opening actually through instead of along the surface and in advance of the brush. This action is, of course, repeated for every slot in succession as it is traversed by the brush, with a loss in efficiency proportional to the number of slots. It, therefore, followed that with but one long slot and one entry, the action of the bristles in pushing the solid matter through the opening would be reduced to a minimum. In addition, it was thought that by using parallel wires to form the slots, the clear openings between could be reduced to at least $\frac{1}{32}$ in. or possibly smaller without danger of clogging. This, in connection with a reduction in the number of entries to one, indicated an increase in efficiency over a screen with slotted plates. Simultaneous field tests run upon the two screens, one of which has slotted plates as already described, show the correctness of this assumption. Interesting data pertaining to these and other tests to follow will be published in a later article.

Automatic Operation

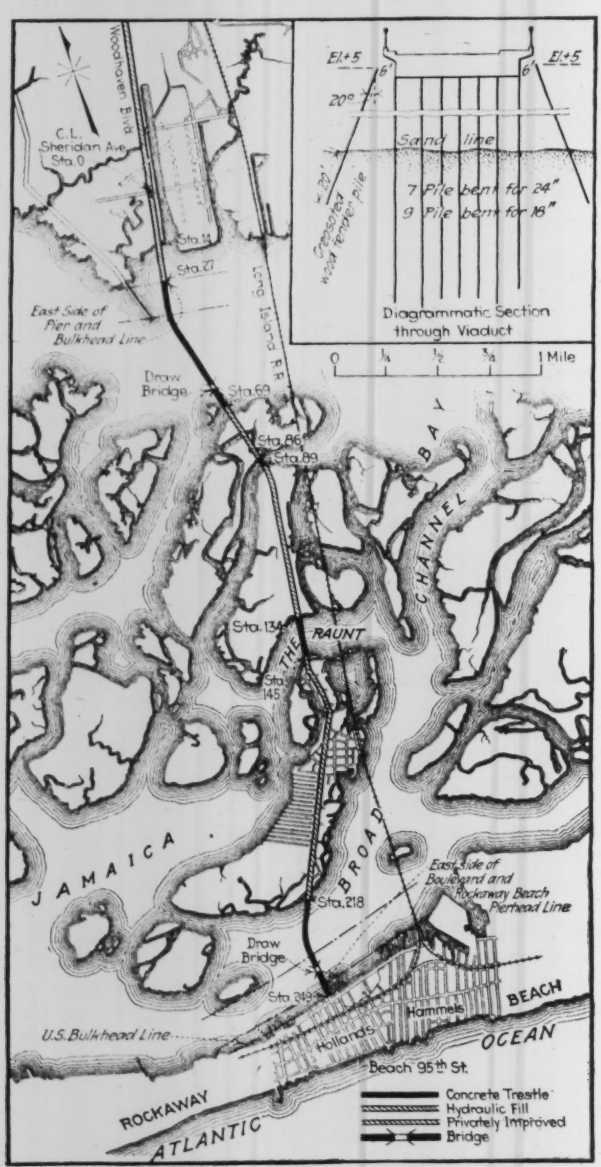
It is necessary to keep the screens in operation only during such times as the flow of sewage into the station is sufficiently heavy to require constant removal of solids from the surface of the screens to prevent clogging. For this reason, constant operation is not required. Like the pumps, the starting and stopping is controlled by floats. The permissible variation in the level of the sewage in the screen chamber is less than 4-in., however, which is not sufficient for direct operation of the float switches. This limitation has been overcome by placing each float in a separate well, formed by a section of flanged pipe supported by and on the top level with the screen floor. When, due to clogging, the water surrounding the screen reaches a level 2-in. above normal, it overflows a small weir, passes through a connecting pipe and fills the float chamber. This causes the float to rise, which in turn starts the screen motor, thus causing the drum and brushes to operate. After one or two revolutions the screen is cleaned and the water returns to normal level. The flow through the pipe leading to the well stops and the contents of the latter then drains out through an orifice in the bottom of smaller capacity than the inlet weir. When the well is about empty, the float shuts off the current and operation of the screen ceases, to be resumed only when clogging occurs again. Repetition of this cycle depends upon the volume of sewage flowing into the station. During part of the day, only, is constant operation required.

The flow of sewage into the station is controlled by a sluice gate, mounted on the wall at the entrance point of the main sewer. Under normal conditions the gate is raised and held in position by a float-actuated, trigger mechanism. If, however, through failure of the pumps to operate, the sludge in the storage reservoir beneath rises to a point where there is danger of flooding the station, the trigger holding the gate in position is tripped, the latter drops and the flow is shut off. Installation of this device has already been justified by failure of the power at night, during absence of the attendant.

Special Concrete Specified for Jamaica Bay Viaduct

Five-Mile Boulevard 52 Ft. Wide to Cross Ocean Bay in New York City Has Nearly 9,000 Ft. of Concrete Trestle, for Which 3,000-Lb. Concrete of Extra Density Will Be Required

CONTRACTS have been let by the city of New York for the construction of a low grade viaduct crossing Jamaica Bay from the mainland at the foot of Woodhaven Boulevard to Rockaway Beach on the Atlantic Ocean front. The total length of the viaduct will be 23,505 ft., of which 8,785 ft. is in reinforced-concrete trestle with two lift bridges and 14,720 ft. in earth fill, behind bulkheads for a small part. The trestle is



GENERAL LAYOUT OF JAMAICA BAY BOULEVARD IN NEW YORK CITY

52 ft. wide and is designed for street car and motor travel. As the concrete is exposed to sea water, special precautions in the way of extra density and high strength are being required of the contractor by the city.

The map above shows the layout of the bridge from which it will be seen that the viaduct, the trestle and earth-fill section succeed each other across the bay depending upon the location of the islands which are very numerous here. Where the islands are at approximately low water level, a fill is used. In the open water, which has rarely a depth of over 6 ft. at present at low tide, the concrete trestle is used. The elevation of the viaduct is from 9 to 31 ft. above mean high water giving a 12-ft. clearance at the small-boat channel and a 4½-ft. clearance elsewhere. Where the deep channels occur are drawbridges, which have a clearance of 24 ft. when closed.

The city is contracting for that section of the fill between Sta. 89 + 34 and 134 + 48, but that part of the fill between Sta. 145 + 74 and the trestle at the Rockaway Beach end of the viaduct is being provided by private interests following the design, however, of the city. Through the construction of the viaduct the distance from the Borough of Manhattan to the Rockaway peninsula will be shortened by about 10 miles, and from the Borough of Brooklyn by about 6.5 miles.

After the design for the viaduct and for the trestle structure were prepared the city called in as consulting engineer Prof. William H. Burr, of New York, to make a critical examination of the plans, particularly in view of the sea-water exposure. The plans as approved and slightly revised by Prof. Burr are being used in the construction. General details of typical sections are shown in the accompanying drawings.

The typical trestle is a reinforced-concrete structure providing a 36-ft. roadway, one 12-ft. sidewalk, and one 4-ft. sidewalk, making a total width of 52 ft., carried on a seven-pile bent of 24-in. reinforced-concrete piles, with girder spans of 24 ft. grouped together in threes so that there is an expansion joint every 72 ft. Prof. Burr rejected alternate designs of creosoted piles on account of the teredo danger after the treatment had been dispersed by time, and also rejected 18-in. reinforced-concrete piles carrying a 24-ft. span and 4-ft. 6-in. concrete cylinders carrying 40-ft. spans. On account of the shortness of the spans, the closeness of the spacing of the piles, and the short distance between the sand line and the floor-beams, it was not thought necessary to use any crossbracing other than that furnished by the floorbeams themselves.

As shown in the details, the trestle structure itself is quite simple. It consists of 24-in. piles which are to be precast and reinforced as shown, reinforcement extending up into the floor-beams. The piles are spaced on 6-ft. 7½-in. centers and stringers are in line above each pile. The floor itself is a reinforced-concrete slab cast integral with the beams and stringers. Provision is made under the wide sidewalk slab for carrying conduits, etc. Expansion joints, as noted, occur every 72 ft. according to the design shown. The railing is a solid section spanning between 12-ft. posts.

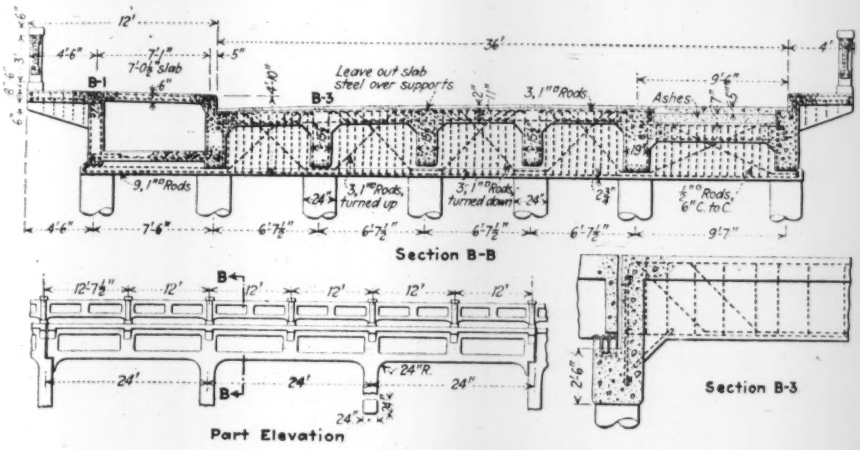
As noted in one of the drawings, the piles are protected by a timber sheathing in accordance with recommendations by Prof. Burr.

The sea-water danger is disposed of as follows in Prof. Burr's report:

> There is serious question whether reinforced-concrete piles, either between high and low water, or above or below

that zone, can be constructed so as to be successfully resistant to sea water. Many statements can be found in engineering literature in which it is alleged that neither plain nor reinforced concrete can successfully withstand exposure to sea water for any material length of time. Wherever such instances of deterioration of concrete in sea water are alleged, it is generally found that the deterioration is due either to poor concrete due to insufficient cement in the mixture or to bad aggregates or insufficient mixing, or some other defect of material or treatment which may be, and should be, controlled.

Prof. Burr then continues and refers to a number of successful reinforced-concrete sea-water structures. He seems particularly impressed with the Aberthaw tests of concrete prisms in Boston Harbor, and on the strength of those tests and of the work done in Halifax Harbor for the Intercolonial Ry. He recommends that the alumina content in the portland cement should not be greater than 6 per cent. His further recommendations are as follows:



CROSS-SECTION OF THE CONCRETE VIADUCT

In view of the extensive successful use of concrete in sea water work, as cited in this report, which has been confirmed by my own experience in similar constructions located at various points on the Atlantic Coast, from New York City north to Portland, Me., it is my recommendation that reinforced-concrete piles be used for this construction, the mixture of concrete for such piles to be equivalent to one cement, one sand and two broken stone, i.e., that the engineer responsible for this construction make investigations with approximately such proportions of mixture for the purpose of determining the most dense mixture possible with the aggregates available in the New York market. For such an investigation the sand may range in size from the finest product of a crusher up to grains with maximum dimensions of ¼ in. while the coarse aggregate may range from ½ in. up to a maximum size of 1 in. A small percentage of the finest product of the crusher is permissible in the production of the most dense concrete possible.

The amount of water to be used in the mixture will depend somewhat upon the character of the mixture of cement and aggregates and should also be determined by actual tests. Preferably it should be "wet" but not too wet or sloppy. Obviously when the concrete is poured into the forms for the piles, it should be thoroughly agitated or "rodded" so as to secure an intimate bond between the concrete and the reinforcing steel and at the same time completely fill every part of the mold. The agitation or "rodding" should be done under thorough inspection and in a complete manner, not only for the purposes above indicated but also to secure the greatest possible density. As indicated in the specifications, the piles should be hardened, or "seasoned" for at least sixty days before being driven.

Although experience shows that a rich, dense mixture of concrete is in itself effectively resistant to any disintegration or deterioration due to freezing and thawing, or to other destructive sea-water influences, it is, in my judgment, prudent to sheath each pile from 3 ft. above mean high water to 2 ft. below mean low water with a 3-in. thickness of timber rigidly secured to the pile. In placing this timber sheathing a heavy asphaltic preparation should be used as a coating to fill any thin openings which might otherwise occur between the sheathing and the concrete of the piles.

This sheathing with its asphaltic lining will not only prevent immediate contact of water with the face of the concrete between high and low tide but it will also guard the protected parts of the pile from any ordinary abrasion such as that due to floating ice, logs or similar debris. If any of the piles should, in spite of such protection, suffer abrasion under extraordinary circumstances, that abrasion can readily be repaired by the use of the cement gun now so commonly employed, or even by other means.

In order to give effective protection to the reinforcing steel from corrosion it is my recommendation that the exterior surface of such steel should be placed at not less than 3 in. from the exterior surface of the pile.

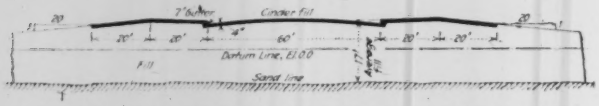
In order to secure the greatest possible supporting frictional area on the exterior surfaces of the piles, I recommend that the cross section be made rectangular but with the corners rounded with a radius of not less than 1½ in. nor more than 2 in. This rounded corner is not needed throughout the depth of penetration of the pile and may be omitted if desired for that part of its length, but it should certainly be used from the top of the pile down to the elevation where pentration begins.

It is my recommendation that the concrete mixture for the longitudinal and transverse beams, or girders, for the roadway should be the same as for the piles, as at many points their exposure during storms will be such as to subject them to heavy spraying. The roadway slabs or plates, however, are distinctly more protected. It is my further recommendation, therefore, that the mixture for these roadway slabs be equivalent to 1 cement, 1 sand, and 3 broken stone, the exact proportions to be determined by actual trial so as to produce the greatest density possible with the prescribed mixture.

It should be insistently observed that in the design and construction of a work of this character with reinforced-concrete members exposed to sea water with a considerable range of tide, the materials to be used should be thoroughly inspected in order to secure the best of their kind for the work contemplated and that the processes of their fabrication should be of the most effective character to accomplish the desired results. Again, through the whole operation of fabrication and putting in place of all parts of the structure, no measure calculated to produce the best results in this field of work should be omitted or even modified in such a way as to reduce the enduring quality of the final work.

All of the recommendations made by Prof. Burr are embodied in the design and in the specifications. Some special features of the specifications in regard to strength and density, however, are of peculiar interest and novelty. The clauses of the specifications in respect to the concrete are as follows:

It is intended to obtain a concrete mixture of the maximum density possible and the contractor should use only the best grade of materials of their respective kinds

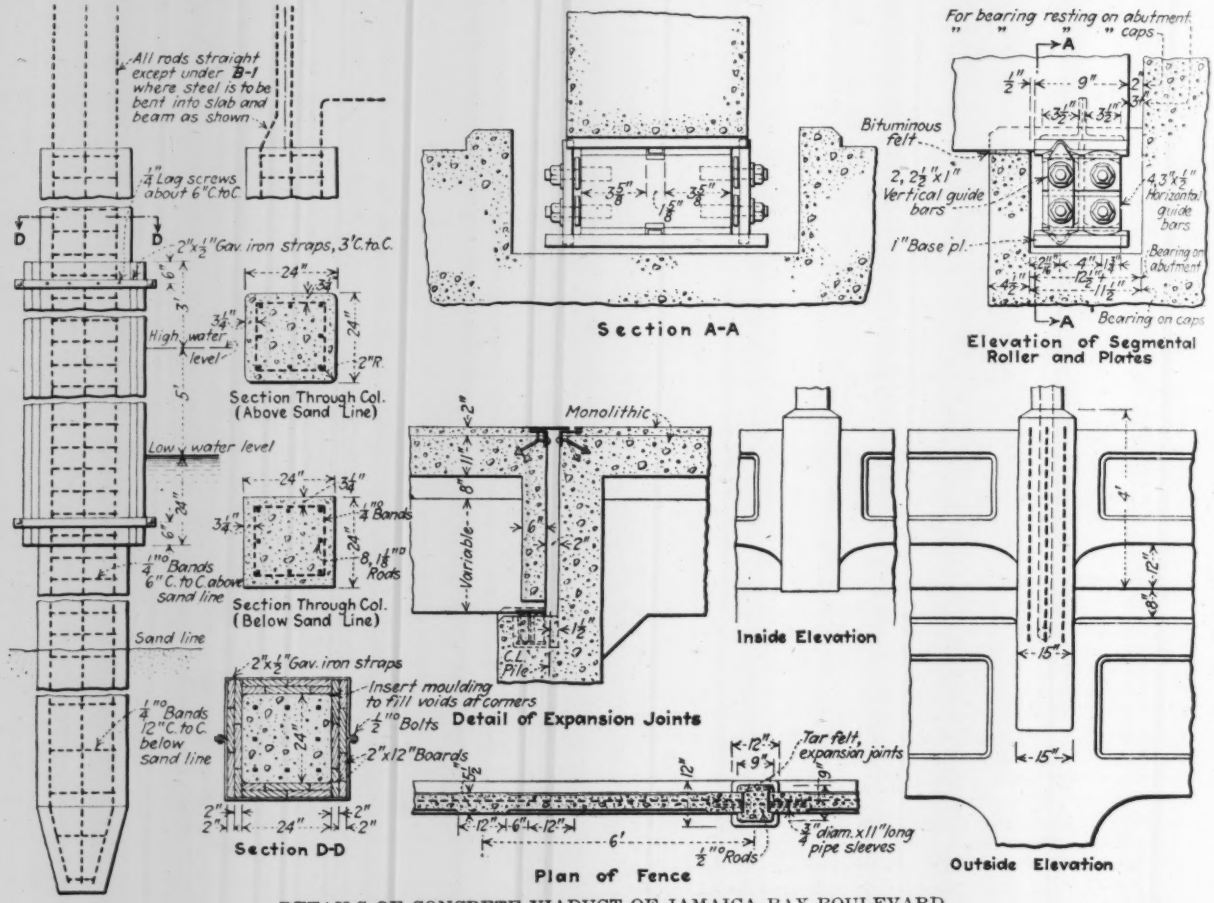


TYPICAL CROSS-SECTION OF EARTH FILL PART OF JAMAICA BAY BOULEVARD

and exercise great care in mixing the materials so that this maximum density and strength are obtained. The minimum requirements for cement are given below, [They are practically the standard specifications except that the alumina content shall not be greater than 6 per cent.—Ed.] but bidders are cautioned that a more finely ground cement than described is at least desirable to obtain the required density and strength of the cement. . . . The sand shall be composed of grains of clean, sharp quartz not softer than hard limestone; it shall be moderately coarse, preferably made up of grains of varying size not exceeding

Concrete Proportions—Reinforced concrete in piles and in the beams and girders shall be mixed in the proportion of 1 part cement, 1 part sand, and 2 parts trap rock or North Shore Long Island gravel. Concrete in abutments and deck of the trestle shall be mixed in the proportion of 1 part cement, 1 part sand, and 3 parts trap rock or gravel. However, should the tests which are to be made as outlined below fail to develop the required strength and density, the proportions of sand and stone may be varied until a mixture is obtained which gives the desired results. In no case shall the proportion of the aggregate be more than 3 or 4, respectively.

It is understood and agreed that the contractor shall make, at his own expense, such tests as are necessary to obtain a mixture of cement, sand and stone which will have a least compressive strength of 3,000 lb. per square inch of cross-sectional area and at the same time a maximum density, the tests to be made on blocks of concrete cast in a cylindrical mold 8 in. in diameter and 16 in. long and


All rods straight except under B-1 where steel is to be bent into slab and beam as shown
1/4" Lag screws about 6" C. to C.
2"x1/2" Gav. iron straps, 3' C. to C.
High water level
Low water level
Sand line
Section Through Col. (Above Sand Line)
Section Through Col. (Below Sand Line)
1/4" Bands 6" C. to C. above sand line
1/4" Bands 12" C. to C. below sand line
8, 1 1/8" Rods
Section A-A
Bituminous felt
2, 2 1/2"x1" Vertical guide bars
1" Base pl.
For bearing resting on abutment
" " " " caps
4, 3"x1/2" Horizontal guide bars
Bearing on abutment
Bearing on caps
Elevation of Segmental Roller and Plates
Monolithic
Variable
C.L. Pile
Detail of Expansion Joints
Inside Elevation
Outside Elevation
2"x1/2" Gav. iron straps
Insert moulding to fill voids at corners
1/2" Bolts
2"x12" Boards
Section D-D
Tar felt, expansion joints
3/4" diam. x 11" long pipe sleeves
1/2" Rods
Plan of Fence

DETAILS OF CONCRETE VIADUCT OF JAMAICA BAY BOULEVARD

¼ in., producing a mass with low percentage of voids. It shall not contain any loam, mica, scales, silt, or other objectionable organic matter, nor any clay or organic matter. It must be so graded that when mixed with a coarse aggregate the required density is obtained.

The coarse aggregate shall be approved trap rock, broken into roughly cubical or pyramidal fragments, or North Shore Long Island gravel. It must pass through a screen with circular openings 1½ in. in diameter and shall be retained on a screen with openings ¼ in. in diameter. It shall be clean and sound and so graded that, when mixed with the proper proportion of sand, as described, the resultant mixture will have less than 16 per cent voids. The engineer will provide such determination of the aggregate as will reduce the voids to a satisfactory minimum.

seasoned one day in moist air and 27 days in damp sand.

The contractor understands and agrees that he is to make the grading and compressive tests at his own expense, far enough in advance of beginning the construction of abutments and casting of the trestle or piles, that he can submit a certified report to the engineer in charge of such tests, including sieve sizes of sand and stone, proportions of cement, sand and stone, quantity of water used, and compressive strength of cylindrical blocks, and not delay its completion. He also understands that he is to furnish at his own expense a sufficient volume of graded materials he intends to use in the concrete mixture, together with the proper quantity of cement, submit the said materials to the engineer in charge far enough in advance of beginning work to enable said engineer to submit the materials to the

laboratory, to make the necessary sieve mixture, etc., to check the test report.

There follows then a tabulation which is reproduced herewith and the following notations:

TABLE OF TYPICAL TESTS
SPECIAL CONCRETE SPECIFIED FOR VIADUCT

Mix	Fineness Modulus	Weight of Mineral Aggregate Cu.Ft.	Slump of Fresh Concrete In.	Water Cement Ratio by Volume	Weight of Concrete per Cu.Ft. at 28 Days, Lb.	Compressive Strength Lb. per Sq. In.
1:1½:2½	5.7	126.5	7¾	0.65	155.3	3,432
...	...	.....	7	0.65	153.0	3,209
...	...	.....	7½	0.65	154.4	3,178
Average 1:1:3	...	.....	7 7/24	0.65	154.2	3,280
...	...	.....	8½	0.66	159.1	3,610
...	6.4	128.5	8	0.56	159.6	3,412
...	...	.....	8¼	0.56	152.9	3,353
Average	...	.....	8¼	0.59	157.2	3,460

The accompanying table shows the results of tests made with concrete mixtures made up of 1 part cement, 1½ parts sand, 2½ parts stone, and also 1 part cement, 1 part sand, and 3 parts stone. These results are given only to show in a general way what combination of water and of fine and coarse aggregate possessing the indicated quality may give the desired result and refer to the above cited mixtures of 1:1½:2½ and 1:1:3 only and not the mixtures of 1:1:2.

At least six cylindrical blocks as herein described and furnished by the contractor shall comply with the compressive and grading tests herein described, and the quantity of graded material submitted to the engineer in charge for investigation by laboratory must be enough for at least six cylindrical blocks that will pass the prescribed tests.

The contractor agrees that he will not begin the casting of piles or columns or the pouring of concrete on any part of the structure until he has received from the engineer in charge the approval of reports of tests of respective materials to be used in this work. . . .

The contractor expressly guarantees the sufficiency of the plans and specifications, to produce the results called for by the specifications.

SPECIFICATIONS COVERING CONCRETE

These blocks after being seasoned as described will be submitted to a crushing test and must not fall below a crushing strength of 3,000 lb. per square inch in cross-sectional area or any part of the work in which the concrete from which the samples were taken has been used will be rejected. The engineer in charge shall determine when such samples shall be taken. The concrete, except in precast piles, will be paid for per cubic yard and placed at the bid price, which price shall include the cost of testing materials, building and removal of forms and falsework and all work incidental thereto:

The precast piles will be paid for per lineal foot in place, which price shall include steel reinforcement, concrete forms, and all labor incident thereto. . . .

For the purpose of determining the proportions of the materials for concrete each bag of cement will be considered as containing 0.9 of a cubic foot. The other ingredients shall be measured by an approved method.

Only clean, fresh water shall be used for mixing the concrete. The amount of water to be used for mixing concrete, giving the specified strength and density, shall be determined by tests to be made under the supervision of the engineer.

After the amount of water has been obtained in this manner the average slump from three cylinders of dimensions stated hereafter shall be ascertained and the amount of water used thereafter shall be such that the slump from cylinders be the same as obtained above. Slump tests shall be made at least once a day before starting work or whenever new material is brought to the work or after change of atmospheric conditions.

An approved apparatus giving positive control for measuring water shall be used and shall be part of the mixer equipment. It must be so designed as to admit the full predetermined quantity of water for each batch to fully discharge into the mixer in not more than 30 sec. after the charging skip reaches the tap.

All concrete shall be mixed in approved mechanical batch mixers so constructed and operated that the ingredients of the concrete may be accurately measured and thoroughly mixed. The mixing of each batch shall be continued for at least 1½ minutes after all materials including water are in the drum or 2 min. if deemed necessary. The number of revolutions of the machine shall be 16 per minute and no variation from this shall be permitted. The drums shall be watertight and provided with a batch meter. No hand-mixed concrete will be permitted.

Concrete shall be deposited from wheelbarrows or other approved appliances in as nearly a continuous operation as is practicable, and shall be rodded and spaded with suitable tools to expel air bubbles to produce a dense and compact mass. It is essential that the spading and rodding be continued long enough especially near the forms so that the surface of the concrete shall be covered with a smooth and impermeable layer of fine aggregate and cement.

The Jamaica Bay Boulevard is being built by the City of New York under the general direction of Maurice E. Connolly, president of the Borough of Queens. The borough engineering bureaus have made the necessary surveys for location and design. The location surveys were made by the Topographical Bureau under the direction of engineer in charge, Charles U. Powell. The original design was made by the Bureau of Engineering Construction, which bureau will also be in responsible charge of the construction. In that bureau Carl T. Steiner has had responsible charge of preparing the designs and in that he has been assisted by B. W. Homans.

After completion the boulevard will be turned over to the Bureau of Highways for maintenance, and the engineering work incident to maintaining the project will be in charge of Fred Shepherd.

The design had to be approved by the Board of Estimate and Apportionment through Arthur S. Tuttle, chief engineer, who is responsible for the approved design of reinforced-concrete piles to the extent of the 3-in. concrete cover over the reinforcing metal; the original design had 2-inch cover.

Contract for the entire structure has been let to Smith, Hauser & MacIsaac, Inc., New York City, for a lump sum of $2,863,280.14.

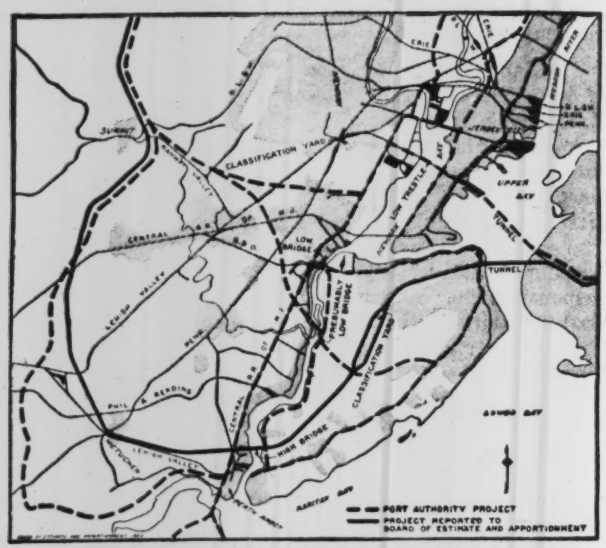
Unemployment in Foreign Countries

According to recent estimates contained in the *Monthly Labor Review*, unemployment in foreign countries is about as follows: Great Britain, 1,484,829 unemployed, representing 12 per cent of all persons insured against unemployment; Germany, 1,250,000 unemployed, representing 2.2 per cent of trade union members; France, 17,970 persons on the live register of employment exchanges, and 18,831 persons in receipt of unemployment benefits from departmental and municipal unemployment funds; Belgium, 147,232, or 21 per cent of those entitled to relief from the unemployment fund, were either out of work or on part time; Italy, 388,744 unemployed; Switzerland, 66,646 totally unemployed and about the same number on short time; Holland, 72,000 on live unemployed; Norway, 15.9 per cent of members of trade unions unemployed; Sweden, 27 per cent of trade union members unemployed; Czechoslovakia, 33,500 unemployed; and Canada, 8.7 per cent of members of the trade unions unemployed.

City vs. Bi-State Plans for Port of New York

Col. Wilgus Outlines Two Schemes and Gives Reasons Why Technical Features of Narrows Tunnel Plan Are Superior

IN A progress report to the Board of Estimate and Apportionment of the City of New York of the city's special committee on the Narrows Tunnel, Col. W. J. Wilgus, consulting engineer to the committee, submits a brief outlining the difference between the city's scheme for developing the port and that of the "comprehensive plan" of the Port of New York authority, now before the legislatures of New York and New Jersey for adoption. The following abstract is from that section of the brief headed "The Narrows Tunnel Preferable to the Port Authority Plan." The accompanying map is a facsimile of the one in the report, which is dated Jan. 23, 1922.



FAC-SIMILE OF MAP IN CITY'S REPORT SHOWING TWO PORT PLANS

Underlying principles must be adopted as guides to a wise decision for the public good. Among them the ones that are believed to have special force [in any plan for improving cross-harbor transportation at New York.—Editor.] are:

1. Fixed charges should be the minimum consistent with the accomplishment of the desired purpose: (a) through avoidance of costly duplicate routes, (b) through utilization of the city's credit for borrowing funds at a low rate of interest, and (c) through the establishment of the route in such manner as to make possible important savings in cost of construction through joint action with other public enterprises.

2. Tonnage to and from Staten Island, Long Island and New England should be routed around rather than through areas in New Jersey that are now or may in the future become congested by reason of their own local freight and passenger development, as for instance between the Orange Mountain range and the waterfront.

3. Crossings of rail and water traffic should be separated through the use of tunnels or high level bridges, so that one will not interfere with the other.

4. Use of temporary mainline structures should be avoided on account of fire hazard and cost of maintenance.

5. Gradients on steam operated new lines should be at least as light as on the railroads with which they are to connect.

6. The classification of freight cars and their suitable consolidation in trains should be provided for in a modern economically planned clearing yard into which all lines will feed, such yard to be so located as to minimize the territory that necessarily must be electrically operated at the start.

7. The portion of the route to be placed in tunnels should be minimized not only because of their cost but also by reason of the unremunerative non-traffic producing character of the territory so traversed.

8. The route should be so placed as to induce the flow of life giving traffic where it will do the most good and the least injury to the communities affected.

Having these principles in mind we may next examine in detail the qualities of the rival plans, that of the city known as the Narrows tunnel plan, and that proposed by the Port Authority.

The Narrows Tunnel Plan

The Narrows tunnel route, as laid out by the writer [Col. W. J. Wilgus] some ten years ago and placed by him at the disposal of the city, has its source in the north at its connection with the West Shore R.R. at Haworth, N. J., and passes thence in a westerly direction to the high land in the rear of Paterson; thence southerly along the rural valley of the Passaic River to a piercing of the Orange Mountains near Summit; thence continuing southerly and easterly through Scotch Plains, South Plainfield and Metuchen to a high level crossing of Arthur Kill between the bluffs that border that waterway in the vicinity of Perth Amboy, N. J., and Tottenville, Staten Island; thence on an easy incline through the midst of the Borough of Richmond to a modern "hump" clearing yard at which cars from many origins may be classified and consolidated into full-sized trains for varying destinations; and thence beneath the Narrows to a connection with the Long Island R.R. and proposed Brooklyn marginal railway in Bay Ridge, Brooklyn, beyond which access to existing and proposed marginal railways, port developments and other local facilities in the boroughs of Brooklyn, Queens, The Bronx and Manhattan; as well as direct connections to New England, is proposed via the New York Connecting R.R. and sundry connections.

The character of construction is proposed to be modern in every respect. On the steam operated section, which is the portion lying west of the proposed yard in Richmond, the maximum gradients are 8 ft. per mile against eastbound and 16 ft. per mile against westbound traffic in New Jersey, while within the limits of the city they descend with the eastbound movement and have a rise of 21 ft. per mile against westbound traffic.

East of the yard, where the intended electric operation makes steep rates of grade unobjectionable, the ruling gradient is 2 per cent in both directions, this being the rate in successful use at other important electric installations in tunnels and elsewhere. Lighter gradients would involve greatly increased expenditures with incommensurate returns in the way of lessened operated costs.

A double-track main line is contemplated, free from grade crossings of every kind, with suitable provision for later expansion to four main tracks when warranted by increase of traffic.

Special attention is paid to the needs of Staten Island. An industrial line is planned along the easterly bank of Arthur Kill, on the opposite side of which, in New Jersey, there is an object lesson in the beneficial effects of adequate railroad facilities. Above all, a direct connection is made with the north shore of the island, on which already exist great ocean piers and warehouses, notably those of the American Dock Co., the Pouch Terminal and the $25,000,000 development of the city itself.

Just where the division line should lie between the portion of this system that should be constructed by the railroads or other outside interests and the portion that should be constructed by the city is a matter for negotiation to determine.

It is hoped that the railroads, through joint action, will organize a Metropolitan Terminal Railroad Association, somewhat similar to the one that has proven to be so successful at St. Louis, under the auspices of which the belt railway may be constructed in New Jersey and at

other places to be agreed upon, and the city's part of the route and certain existing railroad lines may be leased, all with a view to unfied operation at actual cost, in the interest of both the railroads and the public.

By planning in this manner all the principles above set forth are duly recognized. The proposed route involves no duplicate crossings of the bay, it avails itself of the city's credit and it lies where adjoining public facilities may be created with mutual savings of several million dollars, as for instance, through the placing of rapid transit tubes in the same trench across the Narrows and through the placing of a vehicular roadway on the Arthur Kill viaduct, as a means of shortening the journey of automobiles many miles between New York and the New Jersey seacoast resorts. It avoids the congested regions of New Jersey, an item of the greatest importance to the future growth of both states and to the nation, from the standpoint of protection in time of war. It crosses waterways above their heads of navigation in New Jersey, and with its anticipated burden of upwards of 20,000,000 tons annually it passes high over or beneath harbor channels, thereby obviating grade crossings of water and rail traffic, as would be the case if drawbridges were required. Its gradients on the steam operated part of the route, where this question is of moment, are very moderate. Its yard on Staten Island, being of ample length for tandem hump operation, serves all the purposes of economical classification and consolidation and makes unnecessary an extension of electric operation into the existing yards of the trunk lines. Its entire length is available for the industrial development of adjoining territory, except the comparatively short distance in tunnel beneath the heights of northern Staten Island, over the Arthur Kill and under the Narrows. It offers means of trunk line passenger entry to the populous portions of the metropolis, which so far have been neglected in that respect. It does no injury to the New Jersey communities in diverting from their midst New York's cross-water traffic, but on the contrary benefits them by removing a cause for growing congestion. Finally, in turning the arterial flow of New York's commerce through Staten Island, it will change that potentially rich borough from a vermiform appendix to a healthy and prosperous section of Greater New York. Statements have appeared that the project is "impracticable"; that the intent of the law is that the tunnel shall be treated as "an interborough or local improvement" and shall not invade the fields reserved to the bi-state port organization; that it will not stand the test of an economic analysis; that either new costly "break-up" yards will be required at the point of intersection of the proposed belt line with the connecting roads, or expensive "back-haul" of traffic will be required from the existing break-up yards to such points of intersection; and that the outer belt line is a round-about route in contrast with one that would cross the entire width of Upper Bay to the north of the Narrows.

Plan Not Impracticable

Regarding the charge of impracticability, the impression has been given in the press that this lies in the inability of the tunnel to handle both freight and *rapid transit* passenger traffic. This has never been claimed by the city's engineers. What they do claim is that the project is entirely practicable for doing just what the law says it shall do, namely, carry both freight and passengers. The Detroit River tunnel of the Michigan Central R.R. has been doing this successfully for some ten years, and it has been done for some thirty years through the Sarnia tunnel of the Grand Trunk Ry. There is no good reason why it should not be done here, until the time may come in the future when growth of traffic may warrant the laying of additional self-supporting tubes. As to rapid transit passenger service, it has been expected that tubes therefor would be laid alongside those intended to be created under the present law, and the published plans of the city have so indicated.

The charge that the Narrows tunnel project is intended to be a local improvement only is refuted in the act itself.

As to the charge, attributed in the press to the bi-state port organization, that the Narrows tunnel project is uneconomic, no figures have been produced to substantiate it. If it is true of this admittedly necessary and authorized connection between Brooklyn and Staten Island, then it is true in a much greater degree if applied to the dual crossing of the Upper Bay by the tunnel of the Port Authority and the one ordered by the Legislature to be built by the city. Fortunately for the future of the port and for the city—it is not true.

Break-Up Yards Unnecessary

As to the break-up yard statement, a few examples [not given here.—Editor] of yardless junctions will best illustrate its incorrectness. What is the reason then that trains for points east of New York Harbor cannot be made up at divisional yards to the west and diverted over the proposed belt railway of the new clearing yard on Staten Island, where classification and consolidation would enable the traffic to continue in suitably composed trains for various designations on Staten Island, Long Island, The Bronx, Manhattan and New England. It is done elsewhere and it can be done here. Of course there will be fragmentary train lots that will be set off on sidings at the connections and moved thence in "pick-ups" in the usual way, and there will be a comparatively small volume of back-haul freight moving between the Jersey inner zone and eastern points, but these in no manner affect the main question, namely, the feasibility of operating the Narrows tunnel route, coupled with the outer belt railway, without the need for creating extensive new break-up yards at intersections with the connection lines.

As to the alleged round-about nature of the Narrows tunnel route as compared with the Port Authority plan, it is true that the most northerly of the trunk lines, the West Shore R.R., has an excess haul of some 41 miles and that the northerly group of roads as a whole has an added haul of 31.3 miles. However, *per contra*, the one of the southerly group which carries approximately one-half of the entire tonnage of both groups, the Pennsylvania R.R., has a four mile shorter haul than the Port Authority plan, and the entire southerly group, carrying 80 per cent of the tonnage of both groups, has a lesser haul to the extent of 2.7 miles. Taking the traffic of both groups as a whole the average haul by the Port Authority plan is approximately 28 miles and by the Narrows tunnel plan about 33 miles, a difference in favor of the former of 5 miles, or say 18 per cent. At first glance this added haul may seem objectionable, but on reflection it will be realized that a circuitous route is not necessarily less desirable than a direct one if over-balancing advantages are thereby gained. Many illustrations could be given of the creation of round-about lines on which the added cost incident to longer train haul is far more than offset by outstanding advantages similar to those to be gained in this case, namely (a) escape from losses of time and money in passing through yards and congested regions on the existing routes and escape from other violations of the aforesaid fundamental principles of design, including congestion at the proposed bottle-neck at Greenville, and (b) reaping of vast future benefits through access to new traffic producing regions. It is to be expected in this case that the interests of all the roads will be pooled through a terminal association for joint operation, so that no one road will be penalized for its disabilities. The greatest good for the greatest number is the underlying thought of the city's proposition.

If the points as here outlined are well taken, as is believed to be the case, it is apparent that the Narrows tunnel plan accords with the principles that have been laid down as essential to a proper solution of the problem, and that it is free from the defects that have been charged against it from anonymous sources in the press.

In many, if not most respects, the Port Authority plan, is quite similar to the Narrows tunnel plan, except as to the manner of linking together the two sides of the harbor and the promptness with which the construction of the outer belt line shall be undertaken.

The outer belt line of the Port Authority follows the

Narrows tunnel route very closely between North Paterson and Summit, but differs therefrom very materially at the northerly and southerly ends. At the former point it diverges in a northeasterly direction to a terminus at Piermont on the Hudson River. At the south, near Summit, it splits in three directions, one branch passing south to New Brunswick and Perth Amboy where neglected Staten Island is left in all its loneliness across Arthur Kill, another branch passing as a spur beneath Arthur Kill to Staten Island, and the third or main branch joining the so-called middle belt line, over which connection is had with the Lehigh Valley—Pennsylvania R.R. low-level drawbridge and trestle across Newark Bay, and thence by a tunnel beneath what is practically the widest portion of Upper Bay from Greenville to junctions in Bay Ridge, Brooklyn, similar to those proposed in the Narrows tunnel plan.

For immediate construction it is proposed to link the trunk line roads together by means of a so-called inner belt line along the Hackensack Meadows and easterly shore of Newark Bay, which, together with the above mentioned middle belt line and Newark Bay trestle, will bring the traffic of all of the roads from their existing break-up yards to the proposed Greenville-Brooklyn tunnel. Staten Island, pending the construction of the outer belt line at some uncertain date, is to be served by the existing heavily burdened Baltimore & Ohio R.R. stub line on which there is a single track drawbridge kept normally open for the unfettered passage of the Arthur Kill water traffic estimated at 30,000,000 tons annually.

Port Authority Plan Faults

A study of these routes quickly shows that they are not planned in accordance with the aforesaid principles.

First, fixed charges necessarily will be high (a) because the expensive tunnel crossing the Upper Bay will duplicate the cross-bay tunnel at the Narrows which the State has directed the city of New York to build (b) because annual interest charges for this public enterprise, of course paid in the first instance by the shipper and eventually by the ultimate consumer, will be higher by reason of the need for borrowing money directly through bankers at high rates with the usual commissions and discounts rather than through the city with its splendid credit, and (c) because the leaving of Staten Island on one side of the main route robs the project of the savings that would result (1) from the building of the proposed Staten Island-Brooklyn rapid transit tubes in the same trench used for the cross-harbor tunnel, and (2) from the utilization of the crossing of Arthur Kill for both railroad and vehicular traffic.

Second, the anticipated tonnage, far exceeding 20,000,000 tons per annum, will pass through regions in New Jersey now congested with some 75,000,000 tons of rail traffic annually as well as the passenger service of nine trunk lines, and promising to become increasingly so as time goes on, not only through the natural growth of long-haul traffic but also through intensive local passenger and freight growth, neighboring great port developments, and the proposed transshipment of Manhattan freight in the very region in which this inner belt line is proposed to run.

Third, both the main route via Greenville and the B. & O. spur to Staten Island pass over navigable waterways by means of drawbridges, which will embarrass and therefore cause delay and increased cost of operation to both rail and water traffic. Newark Bay waterborne tonnage is large, now reported to cause some 13,000 yearly openings of the drawbridge, with the surety of great increases as the plans of the Port Authority for the deepening of the Newark Bay, Passaic and Hackensack river channels to Newark, Passaic, Paterson and other places are carried out. It is well to quote from page 345 of the 1920 report of the bi-state organization, in its reference to the L.V.-P. R.R. crossing, "Here also tunnels should be built rather than bridges. The Commission assumes that any crossing of the bay as a part of the exterior belt line system will be by tunnel." Also at page 30 of the same report the bi-state organization states "The Commission would further urge . . . that the Federal Government co-operate with the local authorities in providing 30 ft. entrance channels to Jamaica Bay and Newark Bay, and deep water channels within those bays. . . . The bridges over Newark Bay should be replaced, if feasible, by tunnels . . . ."

Thirty-foot channels are not alone intended for light draft craft. On top of all this, further embarrassment is to be expected from the concentration of all of the close-harbor rail traffic at the very point where greatly increased rail movement is to be expected in connection with the Lehigh Valley R.R. new Claremont terminal, the new Port of Newark, the new Droyer's Point water terminal in Jersey City, and other projects which cluster about the place where the proposed "inner belt line" is to join the L.V.-P. R.R. trestle and the tunnel to Brooklyn.

Certainly the former plan of the bi-state organization in this regard was preferable to the later one, which now contemplates drawbridge crossings of these two waterways already having a volume of traffic several times that of the Panama Canal.

Fourth, the intended use of the Newark Bay trestle, unless it is to be replaced with a costly permanent structure, invites the same disaster that in the past has cut traffic in two for a long period due to a fire.

Clearing Yard Necessary

Fifth, the westbound ruling gradient on the outer belt line is understood to be 32 ft. per mile, in contrast with much lower rates on the Narrows tunnel route.

Sixth, no provision appears to have been made for a clearing yard, unless it is intended to build one at Greenville or utilize that of the P. R.R. If none is intended, then there is no provision for consolidating partial train loads going from various origins to various destinations, with resultant costly operation in running light trains or else gross delays and congestion due to holding cars for full train loads, either of which is inadmissible. Moreover, in this case electric operation through the tunnel will have to be extended for long distances to the existing break-up yards of the various railroads, and into such yards, many of which are unadapted to so doing without radical changes. If a yard is intended at Greenville, then the short distance available for yard purposes between the tunnel summit and the place where the lines branch to the north and west forbids a modern yard layout and high cost of operation and congestion are sure to ensue.

Seventh, the portions of the route that are carried on trestle or in tunnels, including the Upper Bay and Newark Bay crossings and the future crossing under Arthur Kill to Staten Island, aggregate with approaches some 18 or 20 miles, which, of course, are unadapted to local industrial development.

Eighth, the route leaves on one side of the main current of traffic the great county and borough of Richmond, with its existing deep-water ocean piers, having an anticipated tonnage of 21,000,000 annually, and the potentially important waterfront along the east bank of Arthur Kill, thereby depriving that promising part of New York of the great benefits that result from an arterial flow of main line traffic through the midst of a community.

No detail maps, profiles or estimates of cost of construction or operation or revenue have been made public by the Port Authority, and, therefore, the student of their plan is in more or less of a fog. Based on what has been published and with what are believed to be reasonable assumptions of what has so far been withheld from the public, it would appear that the Port Authority plan, so far as connections are concerned between the railroads in New Jersey and the boroughs of New York City, is gravely at fault in not having been based on fundamentals which are vital to the effective solving of New York City's cross-bay transportation problem.

It has been shown that the Narrows tunnel plan is grounded on the principles that must have full recognition, if New York City is to profit to the full from an enterprise of such moment; and that the Port Authority plan, in failing to give them recognition will perpetuate handicaps which both sides of the harbor are seeking to eliminate.

After all, the point at issue is not whether the Narrows tunnel or the Port Authority's plan shall be selected, because it is generally recognized that the former in any event should be built. It then becomes a question whether (1) the Narrows tunnel with its outer belt line in New Jersey, or (2) the Narrows tunnel exclusive of the outer belt line *plus* the Port Authority's cross-bay tunnel, inner belt line and Staten Island spur, shall be the adopted plan. In the former case a self contained system, in full accord with the principles heretofore mentioned, is obtained at a cost of say $85,000,000. In the other case the outer belt line portion of the City's plan is rejected in favor of a duplicate tunnel and inner connections in New Jersey, and the total cost of the plan as a whole, with its many objectionable features, becomes say $120,000,000, this figure embracing the unescapable Narrows tunnel terminating in Staten Island and the cross-bay tunnel, connections and improvement of existing facilities in New Jersey as to which it has been necessary to hazard a guess in the absence of any published estimates by the Port Authority. It will thus be seen that so far as can now be judged from available data the city's plan promises a saving of say $35,000,000, coupled with observance of sound principles of design.

There can be but one conclusion and that is in favor of the building of the Narrows tunnel as directed by the Legislature and in conjunction with it the railroad connections which are necessary for its self-support.

Railways Reject Narrows Tunnel Port Plan

IN a letter to Mayor Hylan, of New York City, on Jan. 30, Samuel Rea, president of the Pennsylvania R.R., states that the committee of executives of the railways entering New York "have regretfully but necessarily reached the conclusion that the Staten Island-Narrows Tunnel route could not in the public interest, and in the interest of the railroads carrying the traffic of the public, be adopted or used by them." To this opinion are subscribed the names of all the railways, except that "the president of the Baltimore & Ohio R.R. Co. prefers that his company be not recorded at this time either for or against any plan under consideration."

The letter is accompanied by a lengthy report by the engineering committee of the railways which analyzes the traffic possibilities of the new route and finds them much below those expected by the city and the costs of the proposed plan much greater than by the present method of trans-bay freight handling.

As a deduction from this report the railway executives say "the trunk lines would not be justified in participating in the assumption of the carrying charges for such a large work, including the tunnel under the Narrows, which, in their judgment, is not now, nor in the near future, required for the volume of traffic moving; second, that the approaches to such a tunnel by way of Perth Amboy, and a large bridge over the Arthur Kill, thence traversing Staten Island and tunneling under the Narrows, would entirely change the operation of a majority of the trunk lines whose Long Island and New England traffic would be expected to go through such a tunnel. The Lehigh Valley, Pennsylvania and Jersey Central all have their terminal yards well up towards the New York harbor front on the Jersey side and are constantly expanding the same, and the Long Island and New England traffic now largely moves by water over to Bay Ridge, and the facilities for such movement are ample for the present volume of business and for a considerable increase thereof, and when the traffic demands, and can carry the cost of, direct rail connection, it has been generally conceded that a tunnel on the existing water route, that is to say, from the vicinity of Greenville to Bay Ridge, seems to be the most direct and would seem to accommodate said traffic better and more economically than any other tunnel location so far considered; the cost of a tunnel and connections on that route would be less, and the operation and amortization costs would be much below comparable figures for the Staten Island-Narrows Tunnel route."

Dorr-Peck Activated-Sludge Process Has Been Given Up

AFTER trial of the Dorr-Peck modification of the activated-sludge process at three different test plants, The Dorr Co., of New York City, has concluded that the process does not meet the expectations to which it gave rise and has decided to carry the tests no further. The company's own account of the aims and tests of the process and its conclusion to discontinue work on the process follow:

The Dorr-Peck process was designed to give a greater air economy than had been obtained with other types of activated-sludge units and at the same time accomplish the aeration and sedimentation of the sludge in one unit, It was first tried out on a small scale on municipal sewage at Mt. Vernon, N. Y. [See *Engineering News-Record*, Sept. 9, 1920, p. 490.] The results obtained were encouraging and the air consumption was reduced to about one half that commonly used in rectangular aeration tanks. The original design of the plant was modified during the experiments and it was recognized that at best it was somewhat of a makeshift plant which had not been operated on the normal fluctuation in flows in municipal sewage. Whether or not the low air consumption obtained with a constant flow would be maintained with a fluctuating flow was not determined at Mt. Vernon, and facilities were not available for experimenting with the dehydration of the sludge produced.

The Mt. Vernon test plant was visited by several sanitary engineers and the concensus of opinion was that the results obtained were sufficently encouraging to do further testing with a well designed plant. Arrangements were made for continuing the experiments at Urbana, Ill., in co-operation with the Illinois State Water Survey. The Urbana plant was rated at 100,000 gal. a day and was operated during most of 1921.

After making laboratory tests it was decided to install a Dorr-Peck plant of 25,000 gal. a day capacity at the Argo works of the Corn Products Refining Co. This unit was operated on strong industrial sewage for several months in 1921 and was arranged to work in parallel with the usual type of aerator, followed by a Dorr sewage clarifier for sludge sedimentation.

The Dorr-Peck plants at Urbana and Argo have not given the expected economies and efficiencies and the Dorr Co. has decided to give up any further work with this process.

Pleasing Highway Bridge Design

The matter of aesthetics in highway bridge design has received much more attention of late than ever before and the time is here when the plan of every bridge designed by the state highway commission will receive careful consideration from this point of view. The necessity for good appearance is greater in a permanent structure than in a structure of temporary nature. Permanence ceases to be a virtue where an ugly structure is concerned.—*From Quarterly Report, Jan. 1, 1922, of A. R. Hirst, state highway engineer of Wisconsin.*

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Conflicting Convention Dates

Sir—Replying to your letter Jan. 7, addressed to Gen. Marshall, and attaching copy of editorial note which appeared in your issue of Dec. 15, p. 963. The Chamber of Commerce of the U. S. A., through its fabricated production department, has for the past few months been compiling a list of the convention dates of all associations and societies in the United States of which they have a record. It seems to us that this compilation will be of material assistance to all associations in arranging their dates so that they will not conflict with other important meetings. It might even be well for *Engineering News-Record* to call attention through its columns to the existence of this list for the benefit of other associations and societies.

It might be of interest to you to know that our by-laws require the holding of our annual meeting during the first quarter of the year, so that we are limited to some extent in that direction, and it has become our policy to hold our meeting the latter part of January after our members have closed their books for the year and before the construction season has opened up.

We have had in mind for some time a plan which would bring together in some manner the annual meetings of the more prominent associations in the construction industry. You can readily realize the difficulties in carrying through such a plan, but again your columns might be of assistance in this direction, and by so doing you would be of assistance in "co-ordinating" all important society and association convention dates.

G. W. BUCHHOLZ,
General Secretary, The Associated General Contractors of America.

Washington, D. C.
Jan. 30.

Army Engineers' Early Training

Sir—It is to be feared that your editorial on "Army Engineers' Early Training" in *Engineering News-Record* of Jan. 19, p. 93, may convey a false impression as to West Point and its place in the scheme of military education. The curriculum at West Point is designed to instruct the student in subjects underlying the profession of arms by land. Although commissioned in various branches of the army immediately after completing the course, the military schooling of the graduates is by no means ended, and they are sent to special service schools to qualify them for their duties. West Point is thus, in a sense, a secondary school. It lays an excellent foundation, but it does not pretend to fully fit its graduates for service in the engineers, artillery, cavalry, infantry, or other branches.

If no one in civil life regards West Point as an engineering school, the same may be said of persons in the military establishment. If such opinion ever obtained, it was only in the early days of the institution. In the beginning, the Corps of Engineers and the Academy were one and the same, for the Organizing Act of March 6, 1802, authorized the President to establish a Corps of Engineers, and provided that "the said Corps, when so organized, shall be stationed at West Point in the State of New York, and shall constitute a military acadamy." Moreover, until about 1824—when Rensselaer Polytechnic Institute was established—West Point was the only institution in the United States giving any training in engineering subjects. In 1866 the connection between the Corps of Engineers and the Academy was served, and control of the latter was vested in any officer whom the Secretary of War might elect to serve as superintendent.

Throughout the history of the Academy, only a few graduates from each class have been assigned to the Corps of Engineers, and during the first few years of commissioned service they have always been deemed to be under instruction. During this period of tutelage their work has been performed under the supervision of older officers, and has been so conducted as to further the engineering education and experience of these young assistants.

To facilitate the instruction of the officers newly commissioned in the Corps of Engineers, an Army Engineering School was established immediately after the Civil War. It has been in existence ever since, with the exception of a few brief interruptions caused by the Spanish-American War, the Mexican Border troubles, and the World War. This school is now located at Camp A. A. Humphreys, Virginia, and during and immediately after the World War it conducted instruction in civil, mechanical and electrical engineering subjects, under methods which received the commendation of a number of prominent educators and engineers. Many of the instructors were officers commissioned from civil life for the emergency. The methods evolved have recently been put into practice at several civilian colleges.

However, for reasons indicated in the last annual report of the Chief of Engineers, it has been decided to send young officers to good civilian technical schools for instruction in engineering subjects. Whatever may be the defects of the West Point course, it has been such as to permit these officers, detailed as students at civil schools, to receive the degree of B.S., C.E., with one year in residence, though such year has included some weeks of summer instruction necessary to bridge the gap between the West Point course and the schedule for the senior year at these civil schools. The Engineer School at Camp A. A. Humphreys now conducts instruction in subjects more directly connected with the military service, and in certain subjects of a technical nature pertaining to the duties of the Corps of Engineers not covered by courses at civil schools.

At the present time, three officers of the Corps of Engineers are attached to three important railway systems, and are engaged in detailed study of railway operating. One officer is also on duty with the Transit Commission of New York City. While it is not expected that they will qualify as operators, they will learn some of the problems connected with railway management, and their experience—limited though it be—will prove of value in time of war.

Contact with engineers in civil life is also had through the engineer units of the Reserve Officers' Training Corps at various colleges where young officers of the Corps of Engineers are serving as instructors, and so come into intimate association with students who later will take up the practice of engineering.

It may interest your readers to note that at the present time the Corps of Engineers has an authorized strength of approximately 710, including officers serving with the General Staff, National Guard, Organized Reserves, and on other duties not directly under the jurisdiction of the Chief of Engineers. The Corps actually consists of only 509 officers, of whom 181 have been commissioned directly from civil life, and have never attended the Military Academy. Of the Academy graduates, 85 have also attended civil technical schools subsequent to their entry into the Corps of Engineers, and have received, or will receive the degree of B.S., C.E., for their work. The authorized strength of the Corps has been increased from 248 to about 710, within a period of six years, or approximately 186 per cent. In consequence, only 37 per cent of the officers have had more than five years' commissioned service, and only 56 per cent have had more than four years of such service.

G. A. YOUNGBERG,
Lieutenant-Colonel, Corps of Engineers.

Washington, D. C.
Feb. 2.

Wisconsin's Highways Classified

Classification of the state trunk highway system of Wisconsin, as required by the laws of 1921, has been completed. Of the total mileage of the system, amounting to 7,412, about 1,200 miles are designated as Class A highways (on which a gross load of 12 tons may be carried) and the remainder Class B roads (on which the gross load is limited to 7 tons).

NEWS OF THE WEEK

New York, February 9, 1922

NEW CLUB HOUSE OF THE SEATTLE ENGINEERS' CLUB

Seattle Engineers Occupy New Club House

The Seattle Engineers Club, on Jan. 1 moved its headquarters from the Arctic Club Building to the College Club Building on the corner of Sixth Ave. and Seneca St. A photograph of the new home of the organization is reproduced herewith.

The building, formerly occupied by the College Club of Seattle, is 60 x 120-ft., of brick construction, located within a few blocks of the heart of the business shopping and theater sections of the city. The structure is modern in every respect, containing lounge, library, card, billiard, dining and committee rooms and 22 bed rooms. The club's membership includes more than 200 civil, electrical, mechanical, chemical and mining engineers.

Texas Freight Rates Lowered

The Railroad Commission of Texas has reduced freight rates on sand, gravel and crushed stone when these materials are to be used on road work and the freight is paid either by the county or the state. The minimum carload is specified as 10 per cent over the marked capacity of the car. The new rates are 15 per cent higher than those in effect Aug. 25, 1920 as published in Item 1750 of Texas Lines Tariff No. 2-E. This reduction, effective between all points in Texas on the principal lines, applies only to state and county work and not to municipal improvements.

Federated Engineers Appoint New Committees

The Federated American Engineering Societies has appointed a new committee on registration of engineers. The personnel of the committee is as follows: A. S. Dwight, chairman, New York; Gardiner S. Williams, Ann Arbor, and Philip N. Moore, St. Louis.

A new federal water-power committee also has been named. John H. Finney, of Washington, is the chairman, the other members being Calvert Townley, New York; G. S. Williams, Ann Arbor; Gano Dunn, New York, and A. P. Davis, Washington.

Levee District Bond Bids Called

Bids for $250,000 5 per cent bonds of the fifth Louisiana Levee District will be opened January 20, at Tallulah, La., by the board of commissioners of the parish.

$60,000,000 *Water Supply For Boston District Advised*

As noted in last week's issue, page 209, an additional water supply of 200 m.g.d. from the flood flows of the Ware, Swift and Miller rivers, at a cost of $60,000,000 is recommended for the Boston Metropolitan Water District and the City of Worcester, Mass., by the Joint Board consisting of the State Department of Health and the Metropolitan District Commission in its report submitted to the Massachusetts Legislature on Jan. 28. Supplementary details are given herewith:

The complete project, as planned, includes a 410 billion gallon reservoir on the Swift River at Enfield and a long gravity tunnel, but for immediate construction all that is recommended is a diverting dam on the Ware River at Coldbrook and a 13-ft. tunnel 12 miles long therefrom to the Wachusett reservoir, with provision for pumping water for Worcester from either the tunnel or the Wachusett reservoir, all at an estimated cost of $12,000,000. The diverting dam would provide a supply of 33 m.g.d. but this part of the aqueduct would have a capacity of 500 m.g.d.

A minority report by James A. Bailey, chairman of the Metropolitan District Commission, contends that by continuing the meter extension policy now in force and by filtering the poor supplies the existing sources of supply will be sufficient for the Metropolitan District. X. H. Goodenough, chief engineer of the Department of Health, was chief engineer of the Joint Board, and its chairman was Dr. Eugene R. Kelley, commissioner of health. After the death of F. B. Stearns on Dec. 1, 1919, J. Waldo Smith, chief engineer of the Board of Water Supply, New York City, was consulting engineer of the Joint Board. Further details of the report will be given in a later issue.

Idaho Engineers Meet With Architects

Three Organizations in Joint Session—Irrigation is Leading Topic of Discussion at Rupert

Three organizations of technical men in Idaho, the Idaho Society of Architects, the Idaho Chapter of the American Association of Engineers and the Idaho Irrigation Congress, met in joint session Jan. 16-21, at Rupert. The architects took charge of the first day's meetings, the A. A. E. chapter sessions began the second day, and the real joint sessions were held on the fourth day.

Relation of architecture to engineering, city planning, the state building code, the unemployment situation, utilities valuation, government regulation of railroads, mining engineering methods and a review of the value and extent of the phosphate resources of Idaho were outstanding topics of discussion at the A. A. E. meetings. The annual address of the president, Lee R. Cooke, recommended somewhat more stringent provisions in Idaho's license law for engineers. Resolutions were passed instructing the delegates to the annual convention of A. A. E. at Salt Lake City to work for a reduction in dues.

Irrigation Bills Endorsed

The Irrigation Congress endorsed bills in Congress which contemplate the loan of money to the reclamation fund. It also urged companies contracting for water from the American Falls reservoir to make payments as rapidly as possible so as to convince the Reclamation officials of their good faith.

In his annual address the president of the Irrigation Congress, G. Clyde Baldwin, touched upon the present financial depression which seems to be particularly in evidence throughout agricultural communities and pointed out some of the dangers of any false economy in the maintenance and operation of irrigation projects.

J. C. Wheelon, manager, Twin Falls Canal Co., described a method of cleaning moss and silt from canals with disc harrows. (See *Engineering News-Record*, Aug. 12, 1920, p. 319). Discussion of this paper indicated that the method had many advantages and was coming into more general use.

A paper on "Ditch Riders and Their Duties," by G. A. Remington, manager, Nampa-Meridian Irrigation District, preceded a general discussion of the compensation of irrigation employees for 1922 which emphasized the fact that while loyalty and efficient service cannot be strictly measured by the wage paid an employee, the pay should not be reduced below certain more or less well defined limits if efficient service is to be maintained. Salaries range from $85, with no perquisites, to $175 with allowances for house, telephone and horse feed.

The plans of the proposed Greater Fort Hall irrigation project were out-

License Bill in North Carolina

An engineer license bill has been introduced in the North Carolina General Assembly. It provides for an examination of both engineers and surveyors by a board of five members and the granting of licenses to properly qualified persons who register with the board within one year after the ratification of the act.

Raise Funds for Bust of Eads

At its meeting Jan. 18, the Board of Direction of the American Society of Civil Engineers authorized the raising, by popular subscription, of funds for a bust of the late Buchanan Eads to be placed in the Hall of Fame of New York University. Capt. Eads is the only engineer honored by a place in the Hall of Fame, and the board is requesting from members of the American Society of Civil Engineers contributions of from $1 to $5 as a tribute to the memory of this engineer.

Among Capt. Eads' notable engineering works were the building of the Mississippi River bridge at St. Louis and the maintenance of a channel through the South Pass of the Mississippi River.

Idaho Engineers Meet

(*Concluded from p. 253*)

lined in an address by H. W. Dietz, supervising engineer, U. S. Indian Service, Salt Lake City, Utah. Irrigation project cost-keeping was discussed by Barry Dibble, project manager, Minidoka project, U. S. Reclamation Service.

A paper on the "Capacities of Soils for Irrigation Water," by Prof. O. W. Israelson of the Utah Agricultural College, described the results of numerous laboratory experiments.

Underground Irrigation Water

O. E. Meinzer, chief, underground water division, water resources branch, U. S. Geological Survey, Washington, D. C., presented a comprehensive paper on "Underground Water for Irrigation in Idaho." He described the possibilities of securing yields adequate for irrigation use either by pumping or through artesian wells from the tertiary lake beds, basalt and alluvial deposits existing throughout southern Idaho. Advance census statistics were presented which showed that the average cost of irrigation systems supplied by pumping from wells in 1919 was about $46 per acre with an average annual operation and maintenance cost of $10.07 per acre, wheras the average cost of systems using flowing wells was about $37 per acre with an average annual opueration and maintenance cost of $2.77 per acre. In describing the springs which enter Snake River between Milner and King Hill, Idaho, it was stated that their combined total flow was more than sufficient to supply all the cities of more than 100,000 population in the United States.

Officers elected to head the A. A. E. are as follows: President, E. E. Moberly; vice-presidents, J. E. Wilson and S. T. Baer; secretary-treasurer, E. F. Ayers, Boise. For the Irrigation Congress the following were elected: President, J. E. Badley; vice-presidents, John O. Pincock and J. C. Porterfield; secretary-treasurer, G. C. Remington, Nampa.

New York Firm Gets Contract for Brazil Exposition Building

The contract for the construction of the exposition building to house the exhibits of the United States at the Brazilian exposition, to be held in September, has been awarded to Dwight P. Robinson & Co., New York City. Representatives of the company and Frank L. Packard, architect, of Columbus, Ohio, who will design the building, have sailed for Brazil. Dwight P. Robinson & Co. also has government contracts in northeastern Brazil.

Joins Staff of "Engineering News-Record"

Willard Chevalier, an engineer with long experience in work in and near New York City, formerly general manager of the American Bitumastic Enamels Co. and during the war lieutenant colonel of the 11th Engineers, has joined the staff of *Engineering News-Record* as associate editor.

Col. Chevalier was graduated from the civil engineering course of the Brooklyn Polytechnic Institute and then entered the service of Arbuckle Bros. as assistant to the general superintendent in the mechanical department. Later he became draftsman for the Consolidated Telegraph & Electrical Subway Co. of New York City and subsequently occupied the positions of field inspector and of chief draftsman. His next engagement was as assistant engineer with the Public Service Commission on both the design and construction of the rapid transit subways. In 1912 he became field office manager for the Atlantic Gulf & Pacific Co. on its contract for the construction of the Champlain Section of the New York State Barge Canal, and when that company took in hand the development and promotion of its Mill Basin industrial property on Jamaica Bay, he was transferred to that work.

Served with 11th Engineers

In 1916, as a result of his promotional experience on the Mill Basin project, he determined to enter sales work and became sales manager of the American Bitumastic Enamels Co., but he had hardly got into the work when war broke out. He promptly entered military service and was made captain in the 11th Engineers, of which William Barclay Parsons, the well-known New York consulting engineer, was colonel. He served with that regiment throughout its experience in France, was promoted to the lieutenant-colonelcy of the regiment and returned to the United States in April, 1919.

He at once became general manager of the Enamels Company, resigning that position in October of last year to engage in advertising and public relations work as a member of the Brearley Service Organization.

Col. Chevalier has always taken a very active interest in engineering society work and is now, as the culmination of many years of activity on behalf of the organization, president of the Brooklyn Engineers' Club. He is an associate member of the American Society of Civil Engineers and a member of the Society of American Military Engineers. He has constantly maintained an interest in the work of his Alma Mater and is a past-president of the Polytechnic Alumni Association.

City Manager Bill Introduced in New Jersey Legislature

A bill authorizing the municipalities of New Jersey to adopt the city-manager plan, has been introduced in the State Legislature. Such bills have been introduced and failed of passage for several years in succession. New Jersey is one of only a dozen states in the union that has no city managers but a large number of its municipalities have adopted the plain commission plan.

Indiana Governor Urges Road Building to Aid Unemployment

Governor McCray, of Indiana, as a result of a recent call by representatives of the Central Labor Union regarding the finding of employment for unskilled laborers, has written a letter to Lawrence Lyons, director of the state highway commission, suggesting that the commission start immediately whatever construction work is consistent with good judgment in order that the unemployment situation may be relieved.

Construction Budget for Power Company Is $22,534,000

The Southern California Edison Co. has announced that in its 1922 construction program $22,534,000 will be spent on water-power projects and the extension of the transmission system. This is the largest annual construction budget ever appropriated by the company and is in addition to the $17,500,000 which is to be used during the year for operating expenses, wages, supplies, interest, etc. The construction budget includes $10,951,000 for water power plants proper; $3,333,000 for 220,000-volt transmission lines; $8,124,615 for extensions to distribution lines and substations; and $125,385 for subsidiary companies.

The funds are to be secured by the sale of bonds. Practically all the additional water power is to be generated by plants on Big Creek and the San Joaquin River, where the company has for years been working on a comprehensive program, adding something to the system each year.

To Build Dam and Tunnel

The 1922 program includes work on a 125-ft. dam just below Big Creek power house No. 8, a 5-mile tunnel thence to power house No. 3, which is to have six generating units operating under a head of 855 ft. and developing a total of 200,000 hp. Work on the 13.6-mile tunnel between Florence and Huntington Lakes, which was started in 1920, will be continued this year, the allotment for this season being $1,900,000.

The company now operates a 150,000-volt transmission line 240 miles long, from Big Creek to Los Angeles. This year this line is to be changed over to 220,000 volts, which will be adopted as standard for other high-tension lines to be added to the system. In the ultimate development proposed for the Big Creek-San Joaquin chain of plants a total of six 220,000-volt transmission lines will be required. It is now estimated that by the use of 220,000 volts instead of 150,000 volts the ultimate savings in transmission-line investment will total $30,000,000.

Illinois Society Talks of Modern Surveying

Aerial Mapping Discussed—Other Subjects Included Research and Drainage Prizes Awarded

Surveying, formerly a prominent subject at local engineering meetings, came to the front again at the annual meeting of the Illinois Society of Engineers, held at Decatur, Ill., on Jan. 24 to 26. But it was represented by distinctly modern phases rather than by the once familiar talks on lost corners and the locations of boundary lines. Aerial photography and mapping as a commercial proposition and a sequel to war developments was the subject of a paper by R. C. Diggins, of the Diggins Aviation Co. An analysis of the errors in a transit-tape traverse was given by W. H. Rayner, University of Illinois.

Education in surveying was dealt with in two papers. A new system at Purdue University, described by G. E. Lommel, provides a general course in plane surveying, followed by special separate courses for students in civil, mechanical and electrical engineering, that for the two last dealing largely with building layouts. The University of Michigan, according to T. J. Mitchell, has established a separate diploma department in geodesy and surveying, since it appears that the proper schooling of the surveyor requires more time than that allotted to surveying in the regular engineering course. The dual aspect of surveying, as an independent profession and as a basic part of engineering, was brought out in a brisk discussion following these papers, it being contended that land and property surveying is essentially distinct from engineering survey work.

Sanitary Districts

Sanitary districts, their purpose, organization and plans, were the subject of four papers, two of which dealt with the matter in general. The Indianapolis and Decatur districts were described by J. A. Craven and W. C. Field, respectively. Provision for storm-water runoff in city sewers is a local problem and must be solved in view of the records and experiences of local floods. This was a conclusion presented by C. B. Burdick, Chicago, who pointed out that while correct application of theory is necessary, the greater weight must be given to local records.

Highway research was the subject of an address by Dr. W. K. Hatt, director of the Advisory Board on Highway Research. Road construction is only one element, the general problem being the economics of highway transport. As the engineer has improved and developed railway transportation, so now he has the same field and opportunity in regard to highway transportation. Experimental road work was described by C. A. Hogentogler, highway engineer of the U. S. Bureau of Public Roads, and by H. F. Clemer, testing engineer of the Illinois Highway Department. The former expressed the conclusion that reinforcement is a necessity in concrete roads, but just what is the best form and arrangement of such reinforcement has not been determined. The Illinois highway situation and prospects were reviewed by F. S. Sheets, state superintendent of highways.

That engineers were of greater constructive assistance than lawyers in drafting a revised drainage law, was stated by F. B. Leonard, attorney, in an address on "Legal Aspects of Drainage in Illinois." A review of progress in land reclamation by drainage was given by Prof. G. W. Pickets, University of Illinois. The economic, transportation and construction features of the Illinois barge waterway were given in a paper by M. G. Barnes, chief engineer, which was read by Mr. Cornish, assistant chief engineer of the waterway.

Prizes

Prizes of $25 each were awarded to two of the six papers entered in a competition: "Analysis of Errors in Chaining," by W. H. Rayner, and "Overflow Chambers for Intercepting Sewers," by W. T. McClenahan.

Robert Isham Randolph, Chicago, was elected president, and H. E. Babbitt, Urbana, vice-president of the society. Resolutions passed included: (1) All registered engineers and surveyors, from whatever state, should be permitted to practice in Illinois; (2) a new registration law should be drafted; (3) approval of the recent appointment of an engineer as State Superintendent of (5) revision of the state drainage laws; and (6) endorsement of a diploma department of geodesy and surveying, as established at the University of Michigan.

El Paso Sells $1,850,000 Bonds for Public Improvements

The city of El Paso, Texas, has issued and sold to Stern Bros. & Co., of Kansas City, $1,850,000 in bonds, the money to be expended in public improvements as follows: $500,000, water works; $500,000, school buildings and additions; $250,000, sewer lines; $125,000, sewage disposal plant; $125,000, drainage (storm sewers); $125,000, paving street intersections; $90,000, street grading and extension; $100,000, park extension; $10,000, addition to public library. The water works improvements call for two reservoirs, one of 12,000,000 and the other, 2,600,000 gal. capacity. W. C. Stewart is city engineer.

Development of Canton, China Assured by Contracts Let

Municipal improvements in Canton, China, which have so far included the demolition of the wall encircling the city and building in its place a modern well-paved boulevard, have recently been augmented, according to "Commerce Reports" for Jan. 16, by contracts for several million dollars' worth of terminal facilities. Plans are being drawn for dredging the Pearl River so as to permit ocean steamers, which now come within 20 miles of Canton, to tie up at the city wharfs.

Permit Sought for New 81-Mile Railway in Washington

The Wenatchee Southern Railway Co., Wenatchee, Wash., has filed with the Interstate Commerce Commission, application for permission to construct 81 miles of new railroad main line in the Wenatchee-Kennewick fruit region. The proposed new line will serve the rich apple and fruit districts of Eastern Washington.

What the Colorado River Conference Will Do

Secretary Hoover, Chief of Engineers and Head of Reclamation Service Outline Federal View of Problem

The Colorado River Commission, which met in Washington on Jan. 26, organized in three divisions so that the three major problems may be studied simultaneously. One sub-committee composed of W. F. McClure, of Arizona and F. S. Emerson, of Wyoming, will report on the volume of water available with storage, and the volume available without storage. A second sub-committee made up of W. S. Norviel, of Arizona, Col. J. G. Scrugham, of Nevada, and R. E. Caldwell, of Utah, will study the water requirements of the various states. S. B. Davis, of New Mexico, and D. E. Carpenter, of Colorado, comprise the third division. Since these latter two commissioners are lawyers, they were assigned the legal questions involved, which includes a study of the obligations of the United States under the treaty with Mexico as to the Colorado River.

Hoover's Opening Address

In opening the conference, Secretary Hoover said in part:

"This commission has been established primarily to consider and if possible to agree upon a compact between the seven states of the Colorado Basin, providing for an equitable division of the water supply of the Colorado River and its tributaries amongst the seven states. Such a compact is subject to ratification by Congress and the Legislatures of the various states.

"The problem is not as simple as might appear on the surface for while there is possibly ample water in the river for all purposes if adequate storage be undertaken, there is not a sufficient supply of water to meet all claims unless there is some definite program of water conservation. The commission will, therefore, inevitably be driven into the consideration of a program looking further than the immediate legalistic relationship of the states if it is to find a solution to the problem.

"The federal government is interested through its control of navigation, through protection of its treaty obligations, through development of national irrigation projects and through virtual control of power development depending upon the use of public lands.

"This conference is unique in its attempt to determine states' rights over so large an area by amiable agreement. Indeed it has wider proportions than this in its realization of common interest, need of joint consideration, etc., in order that the greatest possible benefits may be derived for the whole of our people from one of the most precious possessions of our country."

A. P. Davis, director of the U. S. Reclamation Service, told the commission that he has no doubt that there is enough water in the Colorado to irrigate all the lands in the basin and still leave enough for far more power than can be utilized. He pointed out that three-fourths of the water in the Colorado comes from the Green and the Grand Rivers, and that the other tributaries will need their waters locally. He urged that no further burdens be placed on the tributaries. He pointed

$2,500,000 Addition to San Diego Water Supply Advised

Immediate construction of a 116-ft. gravity type masonry dam to store 29 billion gallons of water on the San Diego River at Mission Gorge, 12 miles above San Diego, a filtration plant, and a conduit to the city, are advised by H. N. Savage, city hydraulic engineer of San Diego, Cal., in a report submitted to the city council and water commissioners of that city on Jan. 14. The estimated cost of the project is $2,500,000. Mr. Savage proposes that the dam be built for future raising to such a height as to provide a storage capacity of 95 billion gallons, which would give a net safe daily yield of 12.5 m.g.d. (in place of 5 m.g.d. for the 116-ft. dam) and bring the total cost of the project to $5,250,000. The drainage area of the proposed reservoir is 387 sq. miles, compared with 192 sq. miles for a reservoir at El Capitan, 30 miles up the San Diego River from San Diego, which site was investigated by Mr. Savage.

Colorado River Conference

(*Concluded from p. 255*)

out that mining and other industries in the upper basin are dependent upon the production of food supplies. He made it clear that he does not concede that it is necessary to insure enough water for that part of the basin which lies in Mexico, but he said that question is simplified by the fact that the Mexican area will have all the water it needs.

As to power, Mr. Davis pointed out that it is a mistake to believe that the development of irrigation in the upper basin will not limit the power available below, although he pointed out that the development of power in the upper basin will not interfere with the use of the water below. He cited as one of the great difficulties of the great development, the handling of the salt in connection with storage in the lower river.

O. C. Merrill, executive secretary of the Federal Power Commission, pointed out that applications already are on file covering 4,500,000 hp. of the 6,000,000 hp. which can be developed on the Colorado River. He stated that the Federal Power Commission has suspended all action awaiting the recommendations of the Colorado River Commission. He said that he is perfectly willing to concede that power should be subordinated to irrigation and flood control. He said that the river is capable of producing more power than can be used for generations to come but that reservoirs should be so located as to provide for the gradual expansion of power developments.

Maj.-Gen. Lansing H. Beach, chief of engineers of the Army, said that it is the policy of the Corps of Engineers to interpret proposed restrictions in the interest of navigation, according to a rule of reason. He pointed out that the Supreme Court has ruled that a stream is navigable where navigation has existed or may exist and that the development of the motor boat is resulting in a very material increase in the navigation on rivers. The impression created by his talk, however, was that there would be no interference with the devolopment of the river by the injection of technicalities based on navigation claims.

To Mine Rock Asphalt in Arkansas

An effort is being made to resume operations on the Pike County, Ark., rock asphalt deposits for road work. The high price of cement is aiding the project. A number of years ago this asphalt was extensively mined and some of the best of Little Rock's older streets are paved with the material.

Mining Engineers to Meet

The American Institute of Mining and Metallurgical Engineers will hold its annual meeting at the Engineering Societies Building, New York, Feb. 20-23. In addition to the three-day technical program there will be a number of excursions and a reception and banquet. William Y. Westervelt is chairman of the committee on arrangements.

New York City 80,000 Apartments Short, Committee States

A preliminary report to the New York Legislature by the Joint Committee on Housing, headed by Senator Charles C. Lockwood, states that there is a shortage of 80,000 apartments or housing for 400,000 people in New York City. The shortage of houses that formerly rented at $4 to $11 a room is greater than before the war, the report states.

The committee expresses the opinion that the housing shortage is a menace to health and life. It recommends an amendment to the State Insurance Act that would permit life insurance companies operating in the State to invest up to 10 per cent of their assets as of Dec. 31, 1921, in purchase of land in any first-class city of the State and the erection thereon of apartment houses, tenements and other dwellings, not including hotels, the privilege to terminate on April 30, 1924. As a safeguard against high rentals, a bill already introduced in the Legislature provides that properties improved under its terms shall not be recognized as assets of the insurance companies unless when their construction is begun their "rental value is estimated at $9 a room or less."

It is reported that the Metropolitan Life Insurance Co. has expressed a willingness to invest $100,000,000 in New York City housing, if the proposed legislation is passed, and that in 1921 it loaned $68,000,000 for housing in that city. It is also reported that architects and builders have offered their services and supply men in various lines have offered materials at cost plus all expense, and that labor organizations have expressed a willingness to permit their members to work overtime without any charge for the excess hours, with the understanding that they were given the option of renting 25 per cent of the apartments they helped build.

In estimating the feasibility of providing apartments at $9 and $11 a room allowance is made for the State legislation exempting new housing accommodations from taxation for some ten years, it being assumed that this exemption, which soon expires, will be extended. It is also expected that construction will be carried on by whole city blocks under the best methods available for efficiency and economy.

Washington's Civil Engineers Vote for Federation

By a unanimous vote the Washington Section of the American Society of Civil Engineers, Feb. 3, voiced its desire to become affiliated with the Federated American Engineering Societies. The action was taken in the presence of John R. Freeman, president of the American Society of Civil Engineers, who indicated informally that he was much pleased with the action taken. The motion to join the federation was made by Gen. W. H. Bixby, formerly Chief of Engineers, U. S. Army. The vote followed statements by Arthur P. Davis and L. W. Wallace summing up the federation's accomplishments and giving an outline of its plans.

Freeman Speaks

Mr. Freeman delivered the address of the evening. With the aid of lantern slides he reviewed some of his experiences on the Yellow River in China. He pointed out the more important reasons why flood control on the Yellow River is one of the greatest engineering problems in the world. Incidental to his address, he expressed the opinion that river hydraulics is a much neglected branch of the civil engineering profession. Carefully developed scientific facts with regard to flood control and the handling of river problems generally are not available. He explained how a search of the principal technical libraries of the country revealed that such literature as exists on the subject is largely an expression of opinion. This search revealed that most of the opinions expressed were contradicted by those of engineers of equal standing. Mr. Freeman recommended the establishment of a laboratory at which flood control and other river studies could be pursued.

Consider $20,000,000 Building Program at Yale

James Gamble Rogers, supervising architect of Yale University, New Haven, Conn., at a conference Jan. 23 with city officials, outlined a building program for Yale which may involve the amount of $20,000,000 in new buildings for the university during the next five years.

Plan Flood Prevention Works for Peru, Ind.

The Peru, Ind., flood commission has submitted to the state conservation department plans and specifications for the building of earth and concrete levies, the raising of bridges and the building of ditches to protect the city of Peru from a repetition of the losses caused by the Wabash River flood in 1913. The plans of the flood commission have been submitted to M. J. Stinchfield, assistant state engineer, for inspection, and will later be examined by Dean A. Potter, of the engineering department of Purdue University. Members of the flood commission are R. A. Edwards, W. S. Mercier and Charles L. Vance. The commission was accompanied on its visit to the state conservation department by its engineer, T. N. Jackson, of St. Louis. No estimate was made in the specifications of the cost of the proposed improvements.

Narrows Siphon Submarine Pipe Line Broken by Dredge

One of the three spuds of the dredge "Toledo," which was operating off Tompkinsville, Staten Island, New York City, Feb. 2, on work for the N. Y. Department of Docks, is believed to have been responsible for the breaking of the 36-in. cast iron submarine pipe line, known as the Narrows siphon, which delivers the Catskill water supply under New York Harbor from Brooklyn to the Borough of Richmond. The laying of the Narrows siphon, described in *Engineering Record*, Dec. 19, 1914, p. 656, was a most unusual engineering operation, involving the use of §-in. 36-in. pipe, in 12-ft. lengths, equipped with a special type of flexible joint and laid by means of a 180-ft. curved structural steel cradle with one end attached to a scow and the other reaching to the bottom of a dredged trench in which the pipe line was laid and covered over with a minimum fill of 10 ft.

The depth of water at the point where the accident occurred was 40 ft. The normal daily flow carried by the submarine pipe line was 15,000,000 gal., but after the break occurred this flow increased to 28,000,000 gal., indicating, according to W. W. Brush, deputy chief engineer, Department of Water Supply, Gas and Electricity, that the pipe had not merely been cracked but that a large piece of the line had been broken out and washed away. After the accident occurred the flow at the Staten Island end of the line was completely cut off.

Break Located

Compressed air was turned into the pipe line to locate the break by means of the bubbles arising and divers were sent down by the Merritt & Chapman Wrecking Co., which has been engaged to make the repairs, for an inspection of the line, but at this writing the muddy condition of the water made it impossible to appraise the damage done.

Examinations show that there is a 10-ft. cover of mud over the pipe line. This material is now being removed by means of a bucket and by pumping. Forty thousand circulars have been distributed to Staten Island school children with instructions to take them home to their parents, calling upon members of households to reduce water consumption to the minimum.

Several local pumping stations, securing their supply from wells, have been put in service and are delivering about 12,000,000 gal. daily to the Silver Lake reservoir, which has a capacity of 400,000,000 gal. The normal consumption for Staten Island is 19,000,000 gal. per day, which, in the opinion of Department of Water Supply officials, can be easily cut to 16,000,000 gal. a day without inconvenience to householders. By pumping 12,000,000 gal. a day into the reservoir from the wells and using 4,000,000 gal. a day of the water stored in the Silver Lake reservoir, it will be possible to supply the needs of the borough for at least 100 days.

Details of the break and the probable method of repair are not yet available, although it is probable that a special steel sleeve will be employed to replace the broken section of pipe.

Fire Damages Falsework of New Bridge at Minneapolis

Fire, which will cause about a month's delay and $10,000 damage, occurred Jan. 27 in the falsework supporting the arch centering of the center span of the Franklin Ave. bridge, Minneapolis. An overheated salamander, which was being used to prevent freezing of freshly placed concrete, was the cause of the fire. About 400 cu.yd. of concrete fell into the river when the supporting centering gave way. The existing steel truss bridge, which is being used for construction as well as traffic, was damaged slightly by heat, but will be repaired.

As described in *Engineering News-Record* of Feb. 12, 1920, p. 335, the bridge will contain a 400-ft. span, said to be the longest concrete arch ever built. It was designed by the late F. W. Cappelen.

Vehicle Tunnel Bids Postponed

Receipt of bids for the construction of the Hudson River vehicular tunnel, comprising twin tubes of cast iron 29 ft., 6 in. in diameter, scheduled for Feb. 7, has been postponed to 3 p.m. Feb. 15. It is understood that the delay is occasioned by the difficulties which a number of prospective bidders have experienced in getting surety companies to furnish the bonds called for in the contract. For the entire work the underwriting involves a sum of $4,000,000.

Richards President of Lehigh

Charles Russ Richards, dean of the college of engineering and director of the experimental engineering department of the University of Illinois, has been elected president of Lehigh University at a meeting today of the board of trustees. Dean Richards succeeds Dr. Henry S. Drinker, who retired more than a year ago.

Mr. Richards is 51 years old and was graduated from Purdue University in 1890. After graduation he became an instructor in mechanical engineering in the Colorado Agricultural College, where he remained until 1911, when he went to the University of Nebraska. Since 1917 he has been connected with the University of Illinois.

Kansas City Engineers' Club Aids Water-Works Campaign

The Engineers' Club of Kansas City, Mo., has appointed the following committee to co-operate with the bi-partisan water commission in winning public support for the $11,000,000 bond issue for water-works improvements: Robert E. McDonnell, John Prince, Charles S. Foreman, Ernest E. Howard, Ernest B. Black, Eric W. Bacharach and Hart Cummins. Bonds for this amount and purpose were voted down last November, at the same time that the proposal for establishing the commission was carried. An ordinance for re-submitting the $11,000,000 bond issue to the people on April 4 has been introduced in the city council.

Affiliation Proposed for Boston Technical Societies

Plans have been developed for the creation of an affiliation of technical societies in Boston, Mass., and a prospectus outlining the general scope and the objects of the organization, together with a proposed constitution and by-laws, have been distributed by the organizers of the movement comprising the Boston Society of Civil Engineers, the New England Water Works Association, the Plant Engineers Club, the local sections of the national societies of civil, mechanical, electrical, mining, and heating and ventilating engineers, and the local chapter of the American Association of Engineers. The movement is similar to action recently taken in Philadelphia, Detroit, Cleveland, Chicago, and other large centers.

Such a general organization as is planned, the prospectus points out, will eliminate the present duplication of effort on the part of individual engineering societies and will give opportunity for concerted action on questions which concern technical men either in public or professional life. The affiliation, according to the plans of its proponents, would consist of local technical organizations and would not be made up of individual memberships. The government of the organization would be vested in a council consisting of two representatives from each member organization, the council to have jurisdiction over joint matters.

It is proposed to have the council appoint standing committees as follows: Program, Public Affairs, Finance, Welfare, Employment, and Library. The project could be financed by an assessment of $3 annual per member of each of the affiliated sections.

Slag Association Elects Officers

At the recent animal meeting of the directors of the National Slag Association in Cleveland the following officers wer elected for the present year: L. A. Beeghly, Youngstown, Ohio. president; C. E. Ireland, Birmingham, Ala., vice-president; and H. J. Love, Cleveland, secretary-treasurer.

Urge State To Build Cement Plant in Arkansas

At the annual meeting Jan. 28, of the Arkansas Chapter, American Association of Engineers, a resolution was passed urging the Governor of Arkansas to investigate the feasibility of establishing a cement plant in southwest Arkansas, to be operated by convicts. The action results from a belief that cement manufacturers have kept the price of cement up to such exorbitant figures that both public and private work is held up. Road-building especially is said to be suffering from these conditions.

About 25 years ago a vertical cement mill was built in southwest Arkansas, but with the perfection of the horizontal mill and the consequent reduction in costs of production, the old concern soon ceased to operate. In Little River and Sevier counties abundant material for cement manufacture exists and fuel is cheap and easily obtainable. With the establishment of such a plant it is believed a great reduction could be made in Arkansas road and bridge costs.

Summon Cement Companies to Explain Indiana Road Bids

Representatives of five cement companies have been summoned to appear before Governor McCray of Indiana, Attorney General U. S. Lesh and members of the state highway commission to explain alleged collusion in connection with bids on cement for road construction. A compilation of the bids shows that a number of companies submitted bids which were practically identical on work involving more than $500,000. The same situation exists in regard to some smaller bids. The Governor said he had placed the matter in the hands of Attorney General Lesh to determine whether any legal action should be taken by the state.

The cement companies which have been summoned to appear before the Governor and other state officials are the Atlas, Universal, Indiana, Wabash, and Lehigh.

Bids were also submitted to the commission by a number of other companies, but an examination of the proposals offered by them was satisfactory to the commission, according to officials. The cement companies which have not been asked to appear before the state officials include the Louisville, Sandusky and Kosmos.

Cooper Seeks Power Permit on Columbia River

Col. Hugh L. Cooper has applied to the Federal Power Commission for a preliminary permit covering the important Grande Coulee site on the Columbia River in the State of Washington. This project is covered in the Columbia Basin report issued by the State of Washington. *(Engineering News-Record,* Nov. 11, 1920, p. 944 and July 14, 1921, p. 83.) In that report it is stated that a dam 180 ft. high could be erected at the Grande Coulee site. The Federal Power Commission, using the existing records of the flow of the Columbia River, figures that such a dam would permit of the development of 430,000 hp. Since the principal use of the power would be for irrigation purposes, it is believed that on a pumping-load basis it would be possible to install 1,000,000 hp.

Louisiana Highway Commission Personnel Announced

Formal announcement has been made by Governor John M. Parker of the appointment of William T. Peterman, of St. Mary's parish, La., as president of the newly-created state highway commission. This is the appointment which was forecast some weeks ago in the *Engineering News-Record.* Associated with Mr. Peterman will be Arthur Taylor, of New Orleans, and Duncan Buil, of Royville, Richland parish, La., the two other members of the commission just appointed.

The commissioners will serve for overlapping terms of two, four and six years. No announcement has yet been made of the term of service, though rumor has it Commissioner Peterman will be named for the six-year term, Commissioner Taylor for the four-year term, and Commissioner Buil for the two-year term. All three of the commissioners are experienced in highway construction and engineering. Mr. Buil is the present state highway engineer.

St. Louis Continues Hog Feeding But Plans Incineration

What is hoped may prove to be a temporary contract for a continuation of garbage disposal by feeding to hogs pending the construction of incinerators has been let by the city of St. Louis. The contract, which is to begin Feb. 15, 1922, and run for a year, has been awarded to John F. Klein and Meyer Katz, the city to pay $1.60 per ton for the removal and final disposal of the garbage. The city will deliver the garbage on barges at the municipal dock. The contractors expect to sell the garbage to farmers for hog feeding at points down the river. The city is not obligated to pay anything to the contractors for any garbage that it may dispose of by incineration or otherwise during the year, provided the city gives the contractors thirty days' notice of its intention to make such a change. Under the contract expiring Feb. 14 the city was delivering the garbage to a hog feeder who was paid $2.30 a ton for disposal and who bid $2.40 per ton for the ensuing year of which $1.80 was for freight. A city ordinance has been passed which provides for the construction of two incinerator plants costing about $140,000. The incinerators are to have capacities of 70 to 80 tons in 14 hours, temperatures of about 1,700 deg. and stacks some 125 ft. high. Two more incinerators are planned for later construction. The amount of garbage for disposal ranges from 60 tons in winter to 350 tons in summer. Clinton H. Fisk is director of the Department of Streets and Sewers of St. Louis.

Hoisting of Lumber for Buildings Must Be Done Inside

An amendment to the building laws of New York has been passed and the bill signed by Governor Miller whereby only timber and lumber must be hoisted within a building in excess of five stories in height. The former law was construed to mean that in the construction of buildings five or more stories in height no construction material could be hoisted outside the building. The amendment to the law was caused through the restriction against the handling of steel girders and other heavy framing members.

Engineering Societies

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE. Detroit, Mich.; Annual Convention, Cleveland, Ohio, Feb. 13-16.

AMERICAN RAILWAY ENGINEERING ASSOCIATION. Chicago; Annual Convention, Chicago, March 14-16.

AMERICAN WATER WORKS ASSOCIATION. New York City; Annual Convention, Philadelphia, May 15-19.

The Engineers Club of Kansas City held its annual meeting Jan. 27. Dr. A. H. Cordier delivered an illustrated lecture on "Hunting Birds with a Camera," followed by a talk on "The Lure of the Northwest" by Frank Branch Riley of Oregon. Announcement of officers elected for 1922 will be made later.

The Seattle Engineers' Club held its annual dinner and election of officers Jan. 13. Officers for 1922 are: President, Stuart Mannell, vice-president, Chester F. Lee; secretary, Lyman T. Banks and treasurer, Amos Slater.

The Iowa Engineering Society at its annual meeting Jan. 10 to 13, inclusive, in Sioux City, elected the following officers: President, R. W. Crum; vice-president, Karl C. Kastberg; directors, J. H. Dunlap and C. S. Nichols; secretary-treasurer, L. A. Canfield, Des Moines.

Personal Notes

HARRY L. WILSON and GEORGE E. JOHNSTON civil engineers, have opened an engineering and contracting office in Appleton, Wis.

SAMUEL YOUNG has been appointed chief engineer of the Board of Commissioners of the Port of New Orleans, La. Mr. Young held this position from August 1913, to May 1915, but for the past few years he has been construction engineer for the United Gas and Electric Corporation and for the American Cities Co. on the rebuilding of the power plant of the Little Rock Railway and Electric Co.

REX C. STARR, construction engineer for the San Joaquin Light & Power Corporation has been named chief engineer for the Merced Irrigation District. He will retain his position with the power company.

R. F. RAGLAND, formerly assistant engineer in charge of road maintenance and construction in Yellowstone National Park, is now connected with the state highway commission of Montana.

O. B. BESTOR, assistant to the manager of the department of transportation and communication of the Chamber of Commerce of the United States, has been appointed principal locating engineer for the North Carolina State Highway Commission.

GEORGE E. WOODS has been appointed chief engineer of the Consolidated Gas Co., N. Y., succeeding the late William H. Bradley.

THOMAS H. WIGGIN, formerly principal designing engineer of the Catskill aqueduct for the Board of Water Supply of New York City, has opened an office in New York City for the practice of engineering. His most recent work has been in China, where he served as acting chief engineer of the Grand Canal Improvement Board, returning in 1921, after the completion of the preliminary survey work. During the war Mr. Wiggin, with rank of captain, major and lieutenant colonel, was in charge of the water supply section of the Division of Construction and Forestry of the A. E. F.

O. B. LACKEY, for four years supervising engineer of the Southern Railway System with headquarters at Washington, D. C., has been made city manager of Morganton, N. C.

WILLIAM ORD, for a number of years manager of the paving department of the Lakewood Engineering Co.,

has resigned. Mr. Ord is well known to highway engineers as an expert in concrete paving equipment, plant layout and methods, having installed most of the large outfits furnished by the Lakewood Co. during the last three years.

CHARLES H. LEE, formerly a member of the California state water commission and chief of the division of water rights under the department of public works, has resumed private practice as a consulting engineer in San Francisco.

CHARLES B. WATSON, formerly architectural engineer of the Union Pacific Ry., has joined the Charles L. Pillsburg Co., engineers, St. Paul and Minneapolis, and will have charge of the company's railway engineering work.

GEORGE E. WOODS, heretofore assistant chief engineer and engineer of manufacture of the Consolidated Gas Co., New York, has been made chief engineer, succeeding William Bradley, whose death was noted in these columns recently. Mr. Woods has been with the Consolidated Gas Co. since 1901. Before this he was chief engineer of the Standard Gas Light Co.

WILLIAM CULLEN MORRIS, engineer of construction of the Consolidated Gas Co., New York, has been named assistant chief engineer and engineer of construction. Mr. Morris was successively engineer of the New Amsterdam Gas Co., in charge of the Ravenswood works of that company, assistant engineer of manufacture of the Consolidated Gas Co., and, since 1907, engineer of construction. He is a graduate of Stevens Institute of Technology. In his service as engineer of construction he has had charge of all the development work of the company's main plant, the Astoria plant, which first became an active project in 1902 and started operation in 1906. He has also directed the engineering and construction work of the company's office building, completed in 1914, and the difficult Astoria tunnel completed 1917.

OBITUARY

HARRY FROST, superintendent of the waterworks department of Akron, Ohio, died Jan. 27. He was graduated from the University of Michigan, class of 1908. Before he went to Akron he was an engineer for the Detroit, Mich., water board and chief engineer of the Park and Boulevard Commission.

SIR WILLIAM MATTHEWS, past-president of the Institution of Civil Engineers, England, died Jan. 8 at his home in Hampstead. He was born in 1844 in the Borough of Penzance and engaged in surveying and contracting there until 1864, when he received an appointment to the firm of Sir John Coode, engineer, engaged in harbor, dock, river and estuary work. Twenty-two years later he was made a member of the firm, and remained in active partnership until 1917 when failing health forced him to retire. The firm occupied the position of consulting engineers for harbors and docks to the Crown agents for the colonies and Sir William's duties took him to Ceylon, Hong Kong, Gibralter and Singapore. The firm was also employed by the Admiralty and the Board of Trade, having built the naval harbor at Dover and commercial harbors at Colombo, Cape Town, Folkstone, Peterhead and other ports.

THOMAS P. JOHNSTON, 42 years old, assistant chief construction engineer for the Louisville & Nashville R.R. died suddenly on Jan. 4 at his home in Louisville. He served as a first lieutenant in the Engineers during the World War.

GEORGE W. JACKSON, engineer and contractor, died of pneumonia at his home in Chicago, Feb. 5. After graduation from Purdue University he worked for a number of structual steel firms. About 1904 he organized the Jackson & Corbett Bridge & Steel Works, doing a general contracting business. He supervised the construction of a large part of the freight tunnel system under the downtown business section of Chicago. As a general contractor he built some of the largest water supply tunnels for Chicago, tunnels for telephone and telegraph cables under the Chicago River and the Strickler tunnel in Colorado. He served in a consulting capacity on many of the Great Lakes tunnels built during the last 25 years. At the time of his death he was preparing plans and estimates for a passenger subway system for the city.

EQUIPMENT AND MATERIALS

Device for Proportioning Concrete By Weight

Concrete is proportioned by weighing the aggregates and cement by an apparatus developed by the Lakewood Engineering Co., of Cleveland, O., and recently given practical trial on the Sherman Island hydro electric development on the Hudson River. The proportioner is a steel panel of ¼-in. plate so constructed that it can be framed into any standard bin. At the bottom of the panel are three openings fitted with bin gates. A center gate, 18 x 12 in., is for stone and 12 x 12-in. gates at each side are for sand and cement.

On a shaft extending the width of the plate are three cams, one operating each gate. These cams are adjustable so that they may trip their respective latches when the proper balance is obtained. Keyed to this shaft are bell-cranks forming the scale beams. Three pans of sufficient size to take care of the counterweight necessary for weighing the sand, stone and cement, ride on a vertical shaft. The bottom pan is for stone, the middle pan for cement and the top for sand. The ratio between the weight in the pans and the weight of the material in the auxiliary hopper is one to five.

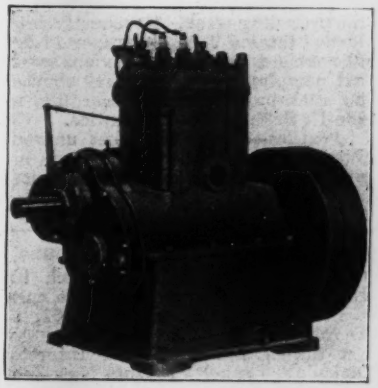
To measure a batch the stone gate is opened and as the weight of the stone in the auxiliary hopper balances the weight in the bottom pan, the pan rises and a cam on the horizontal shaft automatically closes the gate on the stone bin. The cement gate is then opened. When the combined weight of the stone and cement in the auxiliary hopper balances the weight of the two lower pans, the pans rise and a second cam closes the gate. The same cycle takes place in operating the sand gat except that the weight of the materia in the auxiliary hopper must counterbalance the weight of the material in all three pans. The batch is then complete and is dumped into the mixer.

As the material leaves the auxiliary hopper the pans automatically drop to their original positions and the Proportioner is then ready for another batch. So accurately can materials be measured that the error per 1-yd. batch will rarely exceed 50 lbs.

The Lakewood Engineering Co., is manufacturing the proportioner under the patents of Nathan C. Johnson, of Hool & Johnson, New York City.

Small, Two-Cylinder Gas Engine

The Le Roi Co., of Milwaukee, announces a new gasoline engine devoloping from 4 to 8 hp. It is the vertical type, four cycle, and two cylinder with



a 3¼-in. bore and a 4½-in. stroke. A novel feature is that the drive may be taken off at three different points; at either the front or the rear at engine speed or, if slower speeds are desired, the drive is taken off of the camshaft at one-half engine speed. The engine, completely equipped with all accessories including fuel tank, radiator, fan and fan belt and fully enclosed, weighs 325 lb. Without accessories and other equipment the engine weighs 26 lb.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Judge Landis Refuses to Resign As Building Trade Arbitrator

The outstanding feature of the Chicago building trade situation for the past week was the determin tion of Judge Landis not to resign as arbitrator of the building trade disputes. He was asked to do so by petition from eighteen unions. If he would relieve them of further negotiations they contended that the unions could make new agreements amicably with individual contractors. On the other hand renewed pledges of full support of Judge Landis and his award have been given by the two contractors' organizations.

In accordance with a clause in the award on or before Feb. 1 the umpire was to fix the rates to control from May 31 for a period of one year. The contractors have announced that the existing scales would not be attacked, but some of the unions which accepted the award have submitted data and arguments for an increase in the scale.

Trend of Business

Finance—Outstanding investment bonds strong in face of new large loans pending. European exchange firm; sterling $4.38¼; German mark 0.49⅛ cent.

Bankruptcies in January broke all records, Bradstreet's reporting 2,705, which exceeded the former record of December, 1921, by 278, or 11.4 per cent, and that for January, 1915, following the outbreak of the war, by 13.7 per cent.

F. W. Woolworth Co. earned $20.04 a share in 1921. Net profits per dollar of sales were 9.34 cents, which is reported best yield since 1917.

Car Surplus for the week ending Jan. 23 was 396,192 (159,109 box, 183,999 coal, 53,084 miscellaneous), which was 43,790 cars fewer than in the preceding week. Revenue freight loaded totaled 738,275 cars, or 17,398 above the total for the previous week.

Unemployment in January showed no real improvement, according to the U. S. Employment Service.

Textiles—General market uneven. Wage-cutting in the cotton goods industry has caused uncertainty. Retail business light.

Bids Desired on Big Jobs

Among the projects on which bids are either asked or will soon be called in Construction News, pp. 51-61, are the following:

A tunnel and shafts for Interstate Vehicular Tunnel between New York and Jersey City, $25,000,000.

A high school for Columbus, $1,000,000.

A store building for Richmond, Va., $1,000,000.

An office building for New York City, $1,000,000.

A sewer project for Lakewood, Ohio, $654,000.

A bank and office building for New Orleans, $1,000,000.

An office and loft building for Detroit, $1,000,000.

Materials—Production and Stocks

Production Light and Stocks Sufficient for Small Demand—Stocks in 12 Cities

Cement—The production of finished portland cement in the United States in December, 1921, was approximately 6,559,000 bbl. As compared with the production in November, 8,921,000 bbl., this represents a decrease of 2,362,000. A seasonal decline was to be expected, and though the production in December, 1921, was less than in December, 1920, it was about 14 per cent more than the average for December, 1917 to 1921.

The shipments in December, following the usual trend, showed a decrease from November. The movement in December, 3,697,000 bbl., was over 9 per cent greater than that in December, 1920, but was slightly below the average for December during the last five years.

About 11,938,000 bbl. of finished cement were in the hands of the manufacturers at the end of 1921, as compared with 8,941,046 bbl. at the end of 1920. This total exceeded the average stocks in hand at the ends of the years 1917 to 1921 by over 27 per cent. From April until October stocks of finished cement decreased steadily, but in November and December they increased.

Brick—Latest data from the Common Brick Manufacturers' Association are dated Jan. 1, and are as follows:

Dist. No.	Including States of	No. of Firms Reporting	Plants Closed Down	Burned Brick on Hand	Orders on Books	Price per Thousand at Brickyard	Price per Thousand at Brickyard Dec. 1, 1921
1.	N. Y., New England	8	6	16,443,000	2,768,000	$12.00@$20.00	$13.00@$20.00
2.	Pa., N. J., Md., D. C., Delaware	12	7	27,830,000	18,643,000	12.00@ 16.00	12.50@ 16.00
3.	Va., N. C., S. C., Ga., Florida	10	7	11,752,000	5,366,000	6.50@ 18.00	6.50@ 18.00
4.	Mich., Ohio, W. Va.	7	6	8,955,000	1,800,000	12.00@ 15.00	12.00@ 15.00
5.	Ill., Ind., Wis.	28	10	172,582,000	110,056,000	10.00@ 17.00	11.00@ 17.00
6.	Ky., Tenn., Miss., Ala., Ark., La.	13	9	10,057,000	1,731,000	10.00@ 15.00	10.00@ 15.00
7.	N. and S. Dak., Minn., Neb., Ia., Kan., Mo.	9	7	5,336,000	104,000	10.00@ 17.00	11.00@ 17.00
8.	Okla., Tex., N. M.	7	4	5,138,000	1,131,000	8.00@ 14.00	8.00@ 14.00
9.	Wash., Ore., Mont., Wyo., Ida., Utah, Colo.	8	6	2,407,000	1,100,000	11.50@ 17.50	11.50@ 17.50
10.	Calif., Ariz., Nev.	3	..	6,096,000	5,960,000	14.50@ 15.00	14.50@ 15.00
	Total	105	62	266,596,000	148,659,000		

The report of Ralph P. Stoddard, secretary-manager of the association, showed that the number of common-brick plants in the United States capable of immediate operation has shrunk to about 1,200. The Geological Survey in 1900 reported 6,400 brick plants in operation. The reduction of plants has come about largely through the failure of small operators who were not familiar with cost of production or not capable of successful merchandising. The second most important influence is the consolidation of plants into larger corporations, usually resulting in the abandonment of some inefficient yards. The common-brick business of the future is to be done by those concerns who conform to these tendencies of highest plant efficiency and strictly business-like merchandising. The common-brick industry is emerging from a "mud-mixing" business and taking its place beside other industries which believe in organization, standardization and efficiency. Details brought out by the current reports show that the season is having its effect on many plants, and the number closed is greater than since last spring.

In December 53,494,000 brick were produced, and almost exactly the same number were shipped from the plants, leaving the stock on hand only slightly reduced from the month previous. The orders on the books on Jan. 1 were not quite so heavy as the month before, due no doubt to seasonal conditions. Production had practically ceased in New York and New England on account of the weather, but a few plants were running in the fourth, seventh and ninth districts. Stocks on hand in all sections of the country were generally less than a year ago. There has been little change in price.

Steel—The annual production rate of steel ingots for January is estimated at about 22,000,000 gross tons. Demand has shown no improvement since October, 1921, and warehouse stocks though only fair are sufficient. The tendency is evident throughout the country to refrain from piling up large stocks of steel shipped in under existing high transportation charges. Large individual tonnages remain noticeably absent in current buying. Mill operations for the entire industry appear slighty under 50 per cent of capacity.

Lumber movements for the month ending Jan. 28, 1922, as announced by the National Lumber Manufacturers' Association show a total of 644,139,151 ft. cut; 598,449,169 ft. shipped and orders for 619,905,902 ft. Production stood at about 15.5 per cent; shipments 30 per cent and orders 22 per cent below normal for the month. Figures were received from all members, averaging 367 mills reporting weekly to the Association.

Orders, shipments and production according to the American Wholesale Lumber Association reports from various associations, were approximately at the same level for the week ending Jan. 21. Southern pine leads in demand,

receiving in the last four weeks 10 per cent more business than the West Coast.

Rail business, which has been strong due to rate reductions, shows a slight falling off, while export business is unchanged. About 11 weeks of unshipped export business on the Coast will remain unmoved until April 1. Western pine orders are far ahead of production but still much below normal. North Carolina pine demand is about half of the normal.

STOCKS IN TWELVE CITIES

New York—Common brick in hands of dealers and producers in city amount to about 45 barge loads. Brick from Connecticut and northern New York State are being shipped in by rail, water-ways having been rendered non-navigable by ice. Lumber stocks continue large enough to complete deliveries on quantities of yellow pine as large as 300 M. ft. in 9 or 10 days within the Metropolitan District. Hollow partition tile stocks kept comparatively low owing to quick delivery facilities from limited supply from local mills with 24 hr. deliveries. Small stocks of hollow tile are kept in city; deliveries take from 4 to 5 days after receipt of orders. Lumber stocks low with small demand.

Philadelphia—Sewer pipe dealers in this district preparing for a resumption of business from a month to six weeks earlier than last year. Brick demand small at present but yards are working to accumulate sufficient stock for the spring rush. Lumber stocks ample.

Chicago—About 50 cars of lime on sidings, both lump and hydrated. Deliveries on cement, common brick and sewer pipe on the job, within city limits, in a few hours. Large stocks of lumber on hand.

San Francisco—Deliveries on road oils and asphalt in 2 to 3 days. About 4,000 bbl. of lime and 8,000 bbl. of cement on hand. Stocks of two cement corporations, probably aggregating 350,000 bbl., at nearby mills. Lumber stocks amounting to 40,000,000 ft. Going out fast and coming in at the same time. About 15,000 tons of structural steel on hand; 24 hr. deliveries. Stock conditions unchanged during the month.

CONDITIONS OF MATERIALS STOCKS IN IMPORTANT CENTERS

Stocks on hand in approximate figures, example: (cement, San Francisco, 8,000 bbl.); time required for delivery of carload lots to city job, example: (cement, Birmingham, 1 to 2 days); and stocks on hand in general terms, example: (sewer pipe, Los Angeles, plenty.)

	New York	Denver	Detroit	Minneapolis	Philadelphia	Chicago	San Francisco	Birmingham	Los Angeles
Sewer pipe	Ample Immediate deliveries	Immediate del. plant in city	Local stock small	.....	Ample	Immediate deliveries	Good; del. 2 to 3 days	Supply large; plant in city	Plenty Del. 24 hr.
Cement	60,000 bbl. Prompt deliveries	10,000 bbl.	75,000 bbl. Nearby mills	4,000 bbl. Mill del. one day	.....	Del. few hrs.	8,000 bbl. Mill stocks large	800 bbl. Mill del. 1 to 2 days	Large
Lime (common)	Ample	4,000 bu. Del. Missouri lime 10 day to 2 weeks; Colorado one week	20 cars Ohio mills	Plenty 24 hr. del.	Light	25 cars	4,000 bbl.	.....	Sufficient
Lime (hydrated)	Ample		20 cars	Plenty	Light	25 cars	Del. 2 to 3 days	.....	Sufficient
Common brick	200,000,000 at most	6,000,000	Ample Local brick yards	4,000,000	Yards working to replenish stock for Spring	Immediate deliveries	Small; Del. 7 to 10 days	Supply unlimited; local kilns	Large; Del 24 hr.
Hollow tile	From factory to job, 48 hr.	.....	Small Deliveries slow	Small Del. 4 or 5 days	Sufficient	Large	Fair; Del. 2 to 3 days	Plenty	Ample Del. 24 hr.
Lumber	Can complete del. on 300 M. ft. in 9 or 10 days	16,000 M. ft.	10,000 M. ft.	44,000 M. ft.	Sufficient	Large	40,000 M. ft. Arrival 5,000 M. ft. per day	Large mills within 200 miles	No pine. Fir del. 48 hr.

plants within 26 miles of city. Dealers' stocks of sand, gravel, and crushed stone are sufficient to meet all demands.

Denver—Conditions of stocks but slightly changed since last month. About 10 cars of asphalt on sidings as against 5 cars one month ago. Cement stocks about 10,000 bbl. At least 6,000,000 bricks on hand. Immediate deliveries on sewer pipe from plant within the city limits.

Detroit—Plenty of sewer pipe on hand for immediate demands. Not much call for pipe from local stocks in yards. About 75,000 bbl. of cement in stock within the city, and nearby mills to draw from. Lime, both lump and hydrated, shipped from Ohio mills as needed; about 20 cars on sidings at present. Some local contractors maintain brick yards and make their own brick for large contract jobs. Ample supply on hand for all local work. Hollow-tile stocks very small and several days necessary for deliveries from factories. Lumber stocks decreasing slightly. Average monthly stock now about 10,000,000 ft.

Minneapolis—From 3,000 to 4,000 bbl. of cement in local warehouses with unlimited supplies available from nearby mills; shipments on 24 hr. notice. Brick stock is low, running from 3,500,000 to 4,000,000 but can be replenished from yards in district. Lime plentiful; unrate; 5,000,000 ft. having arrived in one day during the latter part of January.

Birmingham—Stock of track supplies small at the present time, but supply of cast iron pipe unlimited at local foundries. Sewer pipe also manufactured locally. Sand shipped in from southern part of state; not more than 10 carloads on hand but deliveries can be made in 1 to 3 days. Crushed slag produced in Birmingham and reinforcing bars rolled at Bessemer, Ala. About 500 bbl. of cement in warehouses but deliveries in carload lots can be made from Leeds, Ala., inside of two days. Brick kilns within city limits; supply unlimited. Plenty of hollow tile and large lumber mills within 200 miles.

Los Angeles—All building materials on hand in sufficiently large quantities to meet all present demands with the exceptions of paving stone and wood blocks, for which there is no market. Deliveries in 24 to 48 hr.

Cincinnati—About 8,000 ft. of sewer pipe and 8,000 bbl. of cement in stock. Small gravel pits shut down; paving stone and wood-blocks obtained on order only.

Seattle—Lumber shipments to California and the Orient unusually heavy; supply equal to the demand.

Montreal—Large stocks of lumber; mill deliveries from 1 to 2 weeks.

North Carolina Plans $20,000,000 Road Program for 1922

The North Carolina State Highway Commission met recently and decided upon a program for 1922 providing for the letting to contract of not less than 1,000 miles of highway construction. Of this amount 400 miles will be of a hard-surface type, consisting of plain concrete, reinforced concrete, and asphaltic types on concrete bases, and 600 miles will be of sand-clay, top-soil or gravel. Most of these 600 miles will be surfaced during 1923. It is estimated that the cost of the 1922 work will be in the neighborhood of $20,000,000.

The highway commission is busy reorganizing its engineering staff, which is under the direction of Charles M. Upham, state highway engineer, to handle the 1922 program. A material survey of the state is being made in the effort to locate sufficient deposits of highway building materials. Provision is being made for increased capacity for testing materials and in addition to the main laboratory the commission is erecting a two-story brick building at its mechanical plant. The most modern road-material testing equipment is to be installed.

Besides the program of 1922, the commission already has under contract some $18,000,000 worth of new work comprising about 1,100 miles.

Cost of Gravel Roads in Indiana County Low

The cost of constructing several roads in Wayne county, Ind., is $213 a mile, while the average cost of constructing roads of this kind in Indiana is $1,200 a mile, says a report of W. O. Jones, county highway superintendent. To aid in the economical construction and maintenance of the road system the county has its own gravel-digging machinery, and last year cut 20,000 cu.yd. at an average cost of 15 cents a yard. The report shows $31,537 in the road fund, which means that the road levy will be cut from 14 cents to 9 cents in 1922, county officials say. Last year the department spent $94,017.

Fall Road Contracts in North Carolina Total $3,000,000

During November, the North Carolina State Highway Commission let eighteen highway contracts for which it received 343 bids. The contracts provide for the construction of 130 miles of road to cost, exclusive of usual additional engineering and contingency fees, approximately $3,000,000. Of that mileage, 90 miles are to be hard surface. The average per mile cost of the hard surface road was $30,654. This included clearing, grading, draining, small reinforced concrete bridges and culverts, as well as paving. Road widths were 16 and 18 ft.

The remaining 40 miles were of sand-clay or gravel construction and cost an average of $4,330 per mile.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted. Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section. The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of February 2; the next, on March 2.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb	$2.63	$3.50	$4.00	$2.63	$2.91	$3.50	$3.10	—$3.36	$4.00
Structural rivets, 100 lb	3.50	5.00	5.50	3.43	3.90	4.25	4.50	4.00	6.50
Reinforcing bars, ¾ in. and larger, 100 lb	2.53	3.20	3.50	—2.53	2.81	3.42½	2.75	—3.26	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	57.65%	45%	57%	61.9-5%	44%	53.7%	53%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	45.00	48.30	—40.60@42.60	—46.00	52.00	50.00	44.00	60.00
Concreting Material:									
Cement without bags, bbl	—2.20@2.30	2.55	—2.40	1.97	2.24	2.90	—2.73	2.94	3.10
Gravel, ¾ in., cu.yd	1.75	1.85	2.00	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd	1.00	1.25	2.00	2.00	.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd	1.75@1.85	2.00	2.93	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	49.00	+37.00	34 00	+44 00	38.00	50.00	32.00	+20.00	.....
Lime, finishing, hydrated, ton	—15.80@16.80	19.00	25.00	18.00	29.00	—24.00	22.00	27.00	26.00
Lime common, lump, per bbl	—2.75@3.48	1.50	2.75	1.40	1.40	—2.70	1.75	2.75	11.00
Common brick, delivered, 1,000	+20 40	—8.50	—11.00	11.00	15.00	14.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.0675	.13	.0821	.0752	.08	....	.10	.08
Hollow partition tile 4x12x12, block	.11120	.0675	.13	.0657	....	.10	—.108	.11	.....
Linseed oil, raw, 5 bbl. lots, gal	+.79	+.85	.93	+.84	+.91	+.95	+.89	.86	.82
Common Labor:									
Common labor, union, hour	—.60	.35	.....	.72½	.40	.50@.55	.62½	.50@.60	... .
Common labor, non-union, hour	.....	.20	.35@.45	.35@.40	.40	.35@.40	.45@.56¼	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars. Gravel, sand and crushed store quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net.

Montreal quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 95.6 cents). Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

Structural shapes are quoted in Seattle warehouses at $3.36 as against $3.60 and reinforcing bars at $3.26 as compared with $3.75 per 100 lb. last week. Although the Pittsburgh mill price of $1.50 on steel shapes and reinforcing bars continues to prevail, it is applicable to increasingly smaller tonnages. Quotations as low as $1.40 per 100 lb. on reinforcing bars have been effected on sufficiently large orders. Mill shipments, New York on shapes and bars are quoted at $1.83@$1.88 per 100 lb. Reduction of $1.80 per ton on cast iron pipe in Minneapolis.

Long leaf yellow pine, base size, quoted in Atlanta at $37 as against $35 per M. ft. b.m., and Douglas fir in Seattle at $20 as compared with $19, one week ago. We quote Colorado lime in Denver warehouses at $24 per ton for hydrated finishing and $2.70 per bbl. (180-lb. net) for common lump. Missouri lime, however, is quoted in Denver at $28 per ton for the hydrated and $2.85 per bbl. for the common lump. The change in price is due to manufacturers' reductions to dealers.

Rising prices of flaxseed are reflected in advances ranging from 2c. to 7c. on raw linseed oil throughout the country. New York reports a rise of 2c., Atlanta 5c., Chicago 4c., Minneapolis 7c., Denver 2c., and San Francisco 6c. per gal. in 5 bbl. lots.

Common brick quoted in Dallas at $11 as against $12.65 and in Atlanta at $8.50 as compared with $9 per 1,000, one week ago. Brick conditions in the North, particularly in New York, are quite different from those prevailing in the Southern states. Ice-bound waterways, causing brick shortage, have produced price advances in New York as against the price declines in the South.

Reports from Oakland, Cal., state that a large amount of residence building has been started in the Bay districts, but that no improvement in the unemployment situation is in sight. Seattle, however, reports gradual improvement in the unemployment situation; street and road work and residence construction materially increased as well as a general improvement in volume of business. Lumber demand, both domestic and foreign, is growing stronger and the upward price trend persists. Mills and logging camps reported operating under full crews.